Analysis on the Constituents and Characteristics of Boundary Crossings in a Professional Development Program

수학과 교사 연수에서 나타난 경계 넘나들기의 구성과 특징에 대한 분석

2018년 2월

서울대학교 대학원

수학교육과

배 미 선

Analysis on the Constituents and Characteristics of Boundary Crossings in a Professional Development Program

수학과 교사 연수에서 나타난 경계 넘나들기의 구성과 특징에 대한 분석

지도교수 권 오 남

이 논문을 교육학 석사학위논문으로 제출함

2017년 11월

서울대학교 대학원
수학교육과
배 미 선

배미선의 석사학위논문을 인준함

2017년 12월

위 원 장 ___최 영 기___ (인)

부 위 원 장 ___이 경 화___ (인)

위 원 ___권 오 남___ (인)

ABSTRACT

Analysis on the Constituents and Characteristics of Boundary Crossings in a Professional Development Program

Mi Seon Bae

The Graduate School of Mathematics Education

Seoul National University

An increasing emphasis is put on teacher participation in the professional development programs and in these programs teachers experience changes in their roles and communities of affiliation as they become a participant, or sometimes become a facilitator even in the scaling-up process. Teachers continuously cross back and forth between the boundaries of communities, cooperate with other participants and create new resources with the given materials through the course of the program, and potentially bring changes to their own instructional practices. There has been various research regarding professional development programs but most are on suggesting or developing a research-designed program via theoretical exploration and analysis on the results of the programs. Research related to the experience of PD programs are mostly based on participants' survey answers collected before and after the PD programs or the experience of researchers being involved as a program developer. Despite the experience of

teachers in a PD program is an important research topic regarding the development of PD programs, studies that explores the constituents or characteristics of boundary crossings by qualitative analysis on this has not been carried out.

This study looked into the professional development program on the 2015 National Reform Curriculum as a case study and interviewed the professional development program developers and participants who are teachers. The interviews were voice recorded and transcribed. Then the professional development program resources and interview transcripts were analyzed to explore the case in two scopes: the constituents of boundary encounters by looking at what the boundary elements, when, and why they appear in each boundary encounters and the characteristics of the boundary elements. Through qualitative content analysis, this research explores the experiences of teachers who are professional development program developers and participants in order to identify how and when the boundaries occur and what their characteristics are. The addressed research questions in this thesis are (1) What are the constituents of the boundary encounters in the 2015 National Reform Curriculum professional development program project? and (2) What are the characteristics of boundary elements in the 2015 National Reform Curriculum professional development program project?

The results of this study showed that the boundary encounters occur when there is an evidence of disparity between people of different delegations. The two different boundary encounters in this case were at the different phases in the course of project. The constituents of each boundary encounters were different according the aims of negotiations in each of the boundary encounters. They are seen as a place for developing and improving meanings than barriers of discontinuities. Yet in both, boundary practices were carried out in order to form mutual understanding among the different boundary

brokers, and concretization and contextualization of knowledge was done as a result of the understanding and negotiation process.

Then the characteristics of boundary crossings were identified and explained in terms of the boundary elements that constitutes the boundaries. The characteristics of boundary brokers were categorized as comprehending, reflecting, negotiable, and motivating. *Comprehending* is reading texts and understanding ideas. Boundary objects were identified in forms of either a medium of boundary crossing and its outcome via the boundary practices. The characteristics were induced as *providing* or *transforming* according to the purposes. Boundary practices such as the dominant form of group discussions in meetings was *imperative* while others were *attempting*.

In this study, it was evident that teachers participate in professional development programs with different goals and purposes according to their original affiliating community. The research results deduced from quantitative analysis presented an overview of constituents and characteristics of boundary crossings that appear in the course of developing and realizing a professional development program. Teachers who take part in professional development programs would be able to practically and effectively use the opportunity by strategically positioning themselves and finding their roles by reacting spontaneously than passively to the situations of crossing between the boundaries of two or more communities.

TABLE OF CONTENTS

List of Tables

I. Introduction

1. Background on the Study

Teachers take part in various professional development (PD) programs every year. When participating in the PD programs, teachers experience changing their roles from the job of teaching to learners who take courses and communities from their original affiliation to the groups formed in PD programs. While the most commonly adopted form of PD program is still lecturing or presenting knowledge in one-direction, there have been research designs that try to transform this rigid structure into a more teacher-involving environment so that they can have hands-on experience on the contents. Especially in such PD programs, teachers are constantly crossing between the boundaries while comprehending the information they are exposed to and cooperating with others. However, there has not been any research that qualitatively analyzes the experiences of PD program developers and participants.

The 2015 National Reform Curriculum PD program was developed in a special setup; it aims at settling down the new curriculum in a nationwide scale by training a large group of participants who are to deliver this PD program in their own communities. Looking at the different perspectives and experiences of people related to the PD program on the 2015 National Reform Curriculum will allow to capture the key features of boundary crossings that occur in PD programs. A number of PD program developers were recommended by the MOE and the list was supplemented by recommendation of those already involved. The group of developers

consisted mostly of teachers and a few researchers and an MOE administrator. Despite their different affiliations, they formed a new group of community with the purpose to design a national-scale PD program, write and make the related educational materials and facilitate the PD courses. This rather demanding role required the PD program developers to carry two different identities throughout the process. Meanwhile, the PD program participants were selected by the Metropolitan and Provincial Offices of Education (MPOE). The PD program participants hold a dual role and responsibility in the macro-aspect. This dual job may be demanding when the two roles are quite different. They are participating the PD program as "learners" but at the same time are potential facilitators in the scaling-up PD programs that will be carried out in their corresponding regional districts as they complete the PD courses.

Both the PD program developers and participants stand on the boundary between two identities; one by their original and the other formed or assigned by their participation in the PD program. Especially the PD program developers and participants for this particular event are "bridge-builders" in that they serve both roles as a teacher participant and a teacher educator, or either a potential one, in the PD program. While trying to understand or serve for the double duty, they constantly cross the boundary between the two. These movements of bridge-building or serving to link connections between different communities of practice or jobs from the social science perspective is called *boundary crossing*, and those who are switching identities at the boundaries are named as *boundary brokers*.

Crossing boundaries, or *boundary crossing*, between and within various communities has been argued to be a source of meaning-making in the field of social science (Wenger, 1998). PD

program developers and participants take part in the PD program by constantly crossing over the boundary of the two communities they belong to during the PD courses. Therefore this research aims to see what characteristics of the boundary crossings across and within various different communities are evident in the experiences of the PD program developers and participants. The areas adjacent to the boundaries in this research are defined with the following communities.

Community 0: Originating community
Community 1: Newly formed community of PD program developers
Community 2: Newly formed communities at the onsite PD course

Community 0 is the community where the research participants originally belong to, such as MOE, teacher educators, and ordinary school teachers. From the aspect that the PD program participants come from all across the country, they can be regarded as coming from various communities that may be different within or across. Hence this community is not a single unique one, but rather a set of communities that each members belong to. Community 1, which is newly formed via this PD program, is a newly formed community with the purpose of developing the programs, PD packet, and onsite courses for the PD program. The community of PD program developers consisted of a university professor, an MOE represenatative, and teachers. Last but not least, Community 2 is another newly formed community at the PD onsite. As PD program participants, the teachers have comparatively more chances to interact with teachers from other schools around the region and they are assigned to sit in groups during the PD course. The community is formed by PD program participants, who are teachers from Community 1, who become in contact with a

few facilitators from Community 0.

Despite it is generally agreed that teachers are the "key" to bring and implement changes in reform ideas in educational policies, reactions and production or movement of difference is waited upon. Typically PD program is chosen for its resulting outcome to be directly intervened and implemented into the classroom (Krainer, 2015). It is generally agreed that all teachers need a PD program on the new curriculum when it is newly introduced (Lee, 2012). The Cascade model, which is one form of scaling-up PD programs, has its strength in that it is one of the fastest and most costly-effective ways (Gilpin, 1997; Hayes, 2000). For the same reason, the Cascade model is often adopted as a means for scaling-up PD program in Korea, where the rather often changing curriculum needs fast implementation after training more teachers in a shorter time.

Yet it carries some risks since the information or knowledge to be transmitted is often transformed or its meaning becoming diluted or distorted (Turner, Brownhill, & Wilson, 2017). The PD program on the 2015 National Reform Curriculum is also vulnerable to this weakness of the structure of Cascade model, where there are discontinuities between the boundaries formed by different groups of people involved. However, I would like to look at those emerged boundaries or discontinuities as a site for meaning making or meaning enrichment via looking at the complex nature and mechanism in boundary crossing in this research.

2. Purpose of Study and Research Questions

All teachers need a PD program that handles the reform curriculum when it is newly introduced in order to understand it better and

prepare for future classes. This is more or less a tacit agreement among teachers and researchers. Teachers read the curriculum document in different ways (Remillard, 1999), and they select and adopt them according to their specific situations, consequently emphasize different concepts and contents (Sherin & Drake, 2009). Despite the differences found in the teachers participating in PD programs, as Sztajn et al. (2013) characterized a mathematics professional development (MPD) to be a rich place to develop the goal of knowledge exchange of different communities, a PD program can be a place where different perspectives of communities meet together to understand each other better and possibly form a mutual understanding.

This research aims to look into the experiences of developers and participants of PD program on the 2015 National Reform Curriculum, where they are demanded to change their roles while they are crossing the boundaries, in order to see when boundary encounters are evident and what the characteristics of boundary crossings are. This thesis addresses the following two research questions:

1. What are the constituents of the boundary encounters in the 2015 National Reform Curriculum PD program project?
2. What are the characteristics of boundary elements in the 2015 National Reform Curriculum PD program project?

The 2015 National Reform Curriculum PD program involved participants who are coming from different background communities with the purpose to support teachers' understandings on the new curriculum and improve their teaching methods. Becoming in contact with other participants, they interact and collaborate with others, form artifacts as an outcome, or potentially transform their ideas or practices. In doing

so, they are building or becoming themselves the bridges between multiple different original communities. In the course of PD program, participants continuously reform the boundaries they are exposed to through this act of "brokering", and this research will analyze the different interactions involved through qualitative content analysis. Also, once the participants complete the PD program, MPOEs planned or plans to invite them to give lectures in the future scaling-up PD programs. In this sense, the so-called "multipliers" of this PD program were not only taking the PD program as for themselves but to responsibly become prepared for the potential role. By analyzing the experiences of the research participants the constituents of the different boundary encounters and characteristics of the boundary elements will be described in this study.

II. Review of Related Literature

1. Teachers' Roles in PD Programs

What are the roles of teachers in PD programs? Despite that teachers used to be perceived as receivers of information, or sometimes a means to mediate information, Kieren, Krainer, & Shaughnessy (2013) identified three characteristics that a research holds where teachers can be the key stakeholders of the research. The characteristics are: using reflective and inquiry-based activities in teaching, producing artifacts made by teachers with the elements of action research evident, and dynamically dual that it is a research and a PD program at the same time. This also includes the perspective embracing teachers as experts and co-producers of academic knowledge.

PD programs developed by a group of teachers is not totally new; it has been around in many different forms according to the background countries. Lesson study (Krainer, 2011) of Japan and Keli approach (Huang and Bao, 2006) of China are examples of PD models which include teachers in the groups of researchers in developing processes of a PD program. Japanese Lesson Study identified teachers' interest, student-centered, research practice, reflective process, and collaboration as the five key characteristics for its success. Keli approach was a reformative PD model developed in the effort of teachers and researchers trying to support teachers who are facing difficulties in classroom implementation in accordance to the new curriculum which emphasizes creative thinking, problem solving, and mathematical exploration.

Yet the complexity in the nature of cross-functional roles

remains despite the successes made in the teacher-involving PD models. The double role to intervene and investigate is a challenge for teachers who are taking part in research (Krainer, 2015). Likewise, the project on the 2015 National Reform Curriculum PD program involved a number of teachers, master teachers, researchers from graduate schools, a university professor, as well as an MOE administrator. This mixture of stakeholders bringing different perspectives to cooperate and a combination of top-down and bottom-up approach in the PD program are symbiotic in nature (Maaß and Artigue, 2013). The group of teachers and researchers were only provided with the document on the new curriculum and a sample PD source book that only covered the common course Mathematics. Hence the original PD program developers had to brainstorm and write up a PD packet that will best explain the meaning of the abstract knowledge written in the curriculum documents from scratch. The transformed knowledge in the PD packet reflects specific teaching guidance or classroom activities that can be taught by the lecturers and comprehended by the participants of the PD program, where both the groups are teachers in ordinary lives.

Didactic transposition explains the process in which academic knowledge or knowledge that may somewhat seem ambiguous is converted into knowledge to be taught with consideration of specific situations and contexts of teaching and learning (Lee, 1996). Through this didactic transposition process, teachers bring into the classroom the awaited contextualized version of academic knowledge, which in opposite pursues de-contextualization for generalization. The triangular relationship of teacher-student-knowledge, where knowledge was often neglected by the mathematical education research in the past, in teaching scheme and the fragility of knowledge are key issues in didactic transposition (Hwang et al., 2016). Likewise, teachers in

classrooms are assigned missions to transmit the knowledge in textbooks without missing out on its essence (Lee, 2005).

<Table 1> Formation and transformation processes of knowledge (Lee, 2005)

1st concretization	curriculum document
2nd concretization	textbook writing
3rd concretization	classroom practice

Nevertheless, before considering concretization of the knowledge that must be transferred to classrooms, writing up the textbook or concretizing its contents must be taken into account since a textbook is an important medium of transition between them. Lee (2005) explained this concept of process by adopting the first, second, third concretization work. Then comes the question of how is this done or more specifically, what transformation and experience do the textbook writers go through as they choose to clarify the to-be-transmissed knowledge that is to be further concretized by teachers in classroom practices. Similar to teachers going through didactic transpositions, textbook writers are "producers" in that they transmit the knowledge while at the same time they create new meanings out of it. Hence, textbook writers need experiences of becoming a teacher as well as a student. While they can easily do so by reminiscing their past of being a student, the experience of becoming a teacher is still ambiguous but realistic, possibly only, when they were or are one.

Among the widely agreed upon view that additional perspectives and communicative validation enrich the scientific research, researches involving teachers refer to them as researchers, reflective practitioners, experts in the literature. As teachers participate in research, their participation builds bridges between researchers and teacher

communities. In doing so, those bridges link between professional knowledge and theoretical knowledge, which the boundaries are often difficult to distinguish. In this PD program, people from separate communities who held different perspectives and values formed groups to discuss and collaborate on developing the program, and also teachers from all across the country were gathered to take part in this PD program and give scaling-up PD programs afterwards. The role of facilitators is very crucial since, as the didactic transposition the original group of facilitators goes through, the scaling-up facilitators implement their PD programs according to the focus and choice of their perspectives (Zwetschler, Rosike, Prediger, & Barzel, 2016). Diversity in backgrounds and perspectives may be beneficial as discussed earlier due to the disharmony or discontinuity in the many boundary encounters they will face and struggle towards a developed and refined goal in the course of events. Hence this research will look at the people engaged and the environments of the PD program in terms of teachers' roles in a scaling-up PD program in order to significance for future research.

2. Boundary Crossing Theory

When two or more communities gather together to look at a topic of knowledge, they hold different perspectives at the initial stage and the differences between these perspectives separate them as well as connect them. While one can discuss on the newly formed boundary as a discontinuity produced in the actions and interactions due to sociocultural differences, it suggests continuity and similarity at the same time. In comparison to the idea that variety is a wall in forming relationships of mutual understanding, boundary crossing suggest that

ambiguity and variety are resources or sources of enriching "dialogical arguments" (Akkerman, Admiraal, Simons, & Niessen, 2006). This effect can be experienced if the communities come together to cooperate using the diversity by accepting the differences and this phenomena as the way it is, despite the initial arguments of each party may not be understood. Wenger (1998) states that boundary crossing is considered a source of meaning-making in the field of social science.

Boundaries are formed at PD programs when individuals from different social communities gather. Leong et al. (2017) pointed out that teachers' active participation in PD programs holds potential influences but making the conditions and environment suitable to successfully cross the boundaries is difficult. When developing a PD program, the three elements of the boundary crossing theory to be considered are boundary brokers, boundary practices and boundary objects (Sztajn et al., 2014). So what are the three elements that describe boundary crossings?

Boundary brokers are the actors, or the main agents, of boundary crossings who are at most time from different background communities. How the groups are formed as a result and how the preliminary relationships between the boundary brokers were are elements that inform how the PD projects are shaped and participants are involved (Akkerman et al., 2006). When the boundary brokers find boundary concepts, boundary practices such as negotiation start to find perspectives that are already shared or to be reshaped by the brokers from different communities. Negotiation plays a essential role because the unique perspectives brought from different individuals' histories make understandings of each other and tasks are interpreted in different ways (Derry, DuRussel, & O'Donnell, 1998). In an MPD, boundary practices are formed around boundary objects, which need

not necessarily be a shared meaning but need a construct that they are artifacts holding similar and different meanings (Sztajn et al., 2014). Hence boundary objects which can hold different meanings in different communities are used translate across the boundaries. These boundary objects are deeply related to finding balance between the ambiguous boundaries, since the newly formed community develops a compatible result through negotiation in boundary practices (Derry, DuRussel, & O'Donnell, 1998).

The sense of different originating communities of individuals can be described in terms of different zones and the dialogical self theory. Zone 1 focuses on an individual's identity, that is their unique life history, and zone 2 is on the representative voice of a newly made community of individuals, and zone 3 is the area of community that the individual originally belongs to. The way an individual, who is exposed to the boundary, speaks up in a representative voice of the individual's community group, social status or society is called the dialogical self theory (Hermans and Kempen, 1993).

Although some try to maintain or stay comparatively independent from the others in the newly formed community, they also are involved in the synthesizing activity of trying to become a whole through cooperation. When several communities form boundaries, they also build up mechanisms involving discussions and cooperation which is called boundary encounter (Akkerman & Bakker, 2011). Akkerman and Bakker tried to identify this mechanism that explains how the entities related to PD program development and onsite PD course are positioned at the boundaries or in the common areas; how this place of knowledge being shared and ideas being produced are adopted and used in their original communities.

The identification process is about reconstructing the current

identity of individuals at the boundaries. That is, finding differences from taking a perspective to look at another, which asks what the fundamental nature of each intersecting areas of individuals or communities in the process of reconstructing the boundaries rather than in the process of overcoming the discontinuities. In this sense, the boundaries are not fixed nor stable, but continuously redefined. Reflection is expanding the perspective or newly constructing an identity by taking the opportunity to look at it from a different perspective. Although not every boundary involves discontinuity, only the appearance of it will stand out as a barrier and lead to discussions at the boundary – a chance to form a consensus on the meanings being discussed.

Looking at the MPD as a boundary encounter, Sztajn et al. (2014) identified the boundary elements which can be summarized as <Table 2>. Here, teachers and researchers involved in the MPD are called 'boundary brokers.' Boundary brokers are who introduce practices of one community to another (Wenger, 1998). People from different communities of practice see an object from their own different perspectives often shaped by the lens of communities they belong to. Despite their originating communities hold different perspectives and knowledge, teachers and researchers had opportunities to share and discuss on the knowledge and its meanings in the course of PD project. However, Sztajn and her colleagues had focused on looking at the process of the PD program only, and defined and described the related elements referring to the boundary theory. The MPD they were working on was in the size of 22 teachers, while the PD program in this research covers more than 500 teachers from all across the country. In addition, their study did not look into the designing and developing process of the PD program as a lump, where

as I take the stance to see the whole process, which took several months to just design and develop the PD program, more than a couple of months to carry out the PD course and another few months for follow-up support of the PD program, for this study.

<Table 2> Boundary elements of MPD (Sztajn et al., 2014)

Boundary encounter	Mathematics Professional Development (MPD)
Boundary brokers	Teachers, researchers
Boundary practices	Collectively doing something together
Boundary objects	Artifacts

Partly in line with Sztajn et al. (2014)'s work, this research will distinguish boundary encounters that can be found in the 2015 National Reform Curriculum PD program project and the corresponding elements to investigate and describe the constituents of different boundary encounters and the characteristics of boundary crossings in the PD program. While Sztajn and her colleagues looked at the processes within how the PD program unfolded onsite and described the various elements that are interwined, this research attempts to look into the phenomena and its subjects in more depth. The different boundary encounters will firstly be distinguished by looking at the PD program project from its development to the program enactment, both the globally and locally from an observing perspective. Then the constituents and the characteristics of each boundaries will be explored through the experiences of the research participants through qualitative content analysis.

III. Methodology

1. Research Setting

This research is situated in the training program for leading high school teachers on the 2015 National Reform Curriculum. This PD program was organized by the MOE and financially supported by the 17 MPOEs so that high school teachers can spend a total of 15 hours on understanding the new curriculum. This high school teachers PD program on 2015 National Reform Curriculum was subject to teachers who are "leading", where the list of PD program participants includes those who are willing to or recommended to participate among high school teachers or experts across the country and professions from MOE or MPOEs. After being provided with this PD program, those who completed the whole course were given a qualification or duty to give a scaling-up PD course in their corresponding district.

The importance of teachers' understandings on the national curriculum is ever so emphasized whenever discussing on the realization of intended curriculum. The MOE and 17 MPOEs prepared a budget to develop and carry out a professional development program on the national reform curriculum for high school teachers so that the teachers can invest time to understand and think about it. Consequently, the MOE commissioned this project planning and administration to the Seoul National University Center for In-Service Teacher Education (SNUCITE). The project, started in March of 2017, provided a quality professional development on the 2015 National Reform Curriculum to a total of 1315 teachers all across the country; 500 Korean teachers, 500 Mathematics teachers, 150 history teachers,

and 150 general social studies teachers during the summer of 2017. Earlier PD program on the 2015 National Reform Curriculum was carried out a year before in 2016, but it only covered Mathematics, the high school common subject. The 2017 PD program and 2016 PD program share their vision and purpose in that they were carried out to support teachers understand the new subject curriculum and improve classroom teaching methods, yet this year's PD program has its strengths in that it covers more subjects within Mathematics for the first time.

The PD program was organized into a preliminary PD course and onsite PD course, which were 5 hours and 10 hours respectively. Teachers could invest time to improve literacy on the new curriculum by reading, understanding, discussing on the provided materials and the PD program serves to actively support and provide a place for such experiences.

2. Research Design

2.1. Role of the researcher

This research was designed in the course of participating in the 2015 National Reform Curriculum PD program as a senior researcher. The researcher had not been able to engage in every single issues discussed in the process of PD program development since the researcher was in charge of general administration of the four subjects in this project rather than belonging to a single subject. Yet, the researcher being in the shoes of an observer for general administration was a merit in the aspect of not being subjective to a particular

community and being able to see between the subjects. This allowed the researcher to find research participants suitable for the purpose of this study.

2.2. Sampling

When this project was consigned from the MOE in March 2017, SNUCITE was given a document with a list of the number of participants assigned for each of the 17 MPOEs. The MPOEs made a recommendation list of teacher participants for the 2015 reform curriculum PD program and a total of 512 mathematics teachers were confirmed as PD program participants of which 441 completed the program. The MOE has also recommended some teachers and researchers chief professors responsible for the subject as PD program developers, who designed and developed the PD program for approximately 500 teachers from all across the country. Participants for this research were sampled through snowball sampling, where the acquaintances suitable for interviews were introduced to the researcher (Merriam, 2005). The research participants were chosen among the PD program developers and participants, who are teachers, without distinguishing physical location since the nature of boundary crossing does not necessary stand that the boundaries are formed by this fact. The recruitment of research participants was carried out until the data collected and analyzed were saturated that any additional data was redundant of the already gathered. In effort to answer the research questions, this research will explore PD program developers and participants experience in being involved in this 2015 National Reform Curriculum PD program.

2.3. Research Participants

Since the names of all the researchers taking part in this PD program development are listed in the research report, information on the research participant was minimized. Because the specificity of this case, it may concern the identity of participants being exposed if their affiliation or job position was noted despite their names put in pseudonyms. In this research, the PD packet developers and facilitators are called 'PD program developers' and the PD program participants or the scaling-up PD program facilitators are called 'PD program participants.'

<Table 3> List of research participants

Research Participant Role in PD project		Role in PD project
PD Program Developer	Interviewee 1	PD packet developer
	Interviewee 2	PD packet developer
	Interviewee 3	PD packet developer
	Interviewee 4	PD packet developer
	Interviewee 5	Region 3 facilitator
	Interviewee 6	Region 1, 2 facilitator
	Interviewee 7	Region 1, 2, 3, 4 facilitator
	Interviewee 8	Region 1, 2, 3, 4 facilitator
PD Program Participant	Interviewee 9	PD participant
	Interviewee 10	PD participant
	Interviewee 11	PD participant
	Interviewee 12	PD participant
	Interviewee 13	PD participant
	Interviewee 14	PD participant
	Interviewee 15	PD participant
	Interviewee 16	PD participant
	Interviewee 17	PD participant
	Interviewee 18	Cascade PD course facilitator
	Interviewee 19	Cascade PD course facilitator

In ⟨Table 3⟩, the teachers interviewed are blind-coded and labeled with a number to avoid exposure of personal information. Among the interviewed, all interviewees were teachers and in order to see their stances and their roles in the PD project are written.

Referring to the number of research participants of Park (2016)'s work, which investigated issues and improvements relating to the curriculum development process, this research has set a least number of participants by taking into account of the case where those asked for are not willing to participate, while those who showed agreement were all interviewed. Interviews were carried out until the collected interview results were saturated that the answers were repetitive and not much new were said.

3. Data collection

This research analyzes the experiences shared by the developers and participants of the 2015 Reform Curriculum PD program and referring to the issues appeared, it aims to infer tasks or discussions for future research or future PD programs regarding curriculum. Among the vast number of decisions being made in the process of national curriculum development, Park (2016) emphasized decision-making regarding the organization of educational content as the core part in the process subject curriculum development. Likewise, the organization of the educational content in developing a PD program for a subject curriculum is the key part.

<Table 4> Method and source of data collection

Form of qualitative data	Data source
Interview (transcripts)	PD program developers and participants' interview – transcribed
Written documents	PD program project proposal 2015 National Reform Curriculum subject curriculum documents PD packet Meeting minutes Project reports

The intent and goal of the 2015 Reform Curriculum PD program was teachers' understandings on the new curriculum. Hence the PD program was developed through fully discussing on the general curriculum and subject curriculum, where the organization of the educational content of the PD course was positioned in the core. Nevertheless, most people are only able to see or have access to the results of the development process regardless of what issues and conflicts appeared in the process and how they were modified and the consensus was made except for those who were involved in the PD program development. Taking a closer look at the discussions and issues regarding the PD program would not only help understand the intent of the PD program, but also aid in coming up with tasks or goals for future PD programs on curriculum.

2015 National Reform Curriculum had endeavored lively discussions between the general curriculum and subject curriculum, and between subject curriculums. SNUCITE also tried to extend this effort in the process of PD program development. Understanding perceptions and perspectives of the PD program developers who were the main actors of the discussions in the process is important and has the

potential to deduce issues and tasks for future PD program development and transmissive PD programs. Not only that, PD program participants' experiences will also do so looking at the PD program from another lens.

Qualitative research method was chosen in order to analyze what experiences the PD program developers and participants have on the new curriculum and its corresponding PD program. The purpose of qualitative research is to describe and understand the essential meanings of research participants' experience, emotions, perceptions, attitude and so forth (Kim, 2016; Creswell, 2007). With respect to this purpose of qualitative research approach, this research was carried out looking at the 2015 Reform Curriculum PD program as a case study of teacher training program as well as that of scaling-up PD program, hence explores and analyzes participants' experiences related to this case.

Research participants were recruited among those who were involved in the PD program development process, such as the chief professor, lecturers, textbook writers, reviewers and subject senior researcher, and those who are participants of the PD program. Despite the number of PD recipient was 500, this research only recruited participants who showed favourable attitude and had graduated the PD program, that is, taking both preliminary PD course and onsite PD course fully. Hence the research participants will be recruited via purposive sampling so that they are the best representative case studies for the research questions.

The fact that this PD project was conducted by the MOE and funded by the 17 MPOEs in order to train a sample of lead teachers from all across the country then the MPOEs can plan transmissive PD programs as follow-up programs carried out by the PD program

participants makes this research hold sufficient representativeness as a case study. Research participants were contacted during and after the PD program, and the in-depth interviews were made after 2 to 3 months the PD program was carried out. While interviewing, interviews were audio recorded with agreement and journal of researcher's impressions and observations were made during every interview to keep track of emerging themes that seem important in this research as potential research findings.

This research has its stance in qualitative content analysis as research method, where the 2015 National Reform Curriculum PD program is regarded as a case study and the related participants experiences are collected and analyzed. Analysis was made together at the same time with the interviews, and the interviews were semi-structured to that can be supplemented at moment-to-moment during interviews. Interviews were made in-depth, face-to-face except for the cases where the research participants could not schedule up a meeting time and hence interviews were held via phone calls.

Before the main interview, the research participants were contacted and were fully explained about the purpose of this research, its meaning, and how the data is going to be used et cetera before they agreed to spare time for interviews. In this preliminary stage, a short interview was carried out in order to find the appropriate sampling for the research purpose. So once the interviewees agreed to participate in this research, their background information was asked for rapport formation in advance to the main interview for data collection. These questions were asked for both PD program developers and participants.

Part 1. Background information
  1. Teaching career

2. Responsible grade group or school job
3. Experience as a scaling-up PD course facilitator or reform curriculum PD program participant

In the interview, they were asked about their experiences of participating in the PD program; participating in the developing process and facilitating the onsite programs to the PD program developers, and participating in the PD courses and preparing or giving a PD course as a facilitator to the PD program participants. As Bogdan & Taylor (1975: 95-124) tipped hint on structuring an interview, the researcher allowed time to form some rapport with the participant and then let him or her to willingly share his or her concerns and opinions at his or her own speed. In effort to answer the research questions, this research has made a list of questions for a semi-structured interview. The questions were modified from a questionnaire on the process of curriculum development in Park (2016)'s work with the consideration of Bogdan and Taylor's suggestions for interviewing and probing while socially interacting inoffensively. It was modified to include the role changes of teachers at different community environments. The semi-structured interview to help them recall about their experiences in and out of the PD program. During the in-depth interview, the questions asked were expanded from a series of the following prepared questions. The following is the list of questions, which was revised in advance in a pilot study, used for teachers who were PD program participants.

Part 2. Teacher → PD program participant
1. What do you think was the purpose of this PD program? What made you think so?
2. Do you think the PD program had achieved to meet its target goals? In what parts did it or did it not do so?
3. What made you sign up for this PD program?
4. Did you reach your objectives or goals through participating in this PD

program? Why do you think so?

5. What was special about this PD program, differentiating itself from other PD program? Is there anything that you were unsatisfied with or wish to be improved?

Part 3. PD program participant → teacher or future PD program facilitator
1. What were your focuses while participating in the PD program as a future facilitator in the scaling-up PD program?
2. Were there any changes in your understandings on the new curriculum and its practice before and after the PD program? Sharing any changes in your thoughts are perspectives would be appreciated.
3. How did the experience in PD program affect you in preparing for the transmissive PD course as a facilitator?
4. How did the experience in PD program affect you when you got back to your original community?
5. What are the knowledge or attitude one should hold as a facilitator in a scaling-up PD program?
6. What improvements should be made on the PD program to have a more constructive effect on the community?

The teachers who were PD program developers were interviewed using the questions below which were also revised in advance in a pilot study. Except for the first couple of questions, different questions were used that were more specifically customized to their roles.

Part 2. Teacher → PD program developer
1. What do you think was the purpose of this PD program? What made you think so?
2. Do you think the PD program had achieved to meet its target goals? In what parts did or did not?
3. What were your opinions on the PD program in the beginning of the project?
4. How did you split and the job in the PD program development?
5. What were you in charge of and why did you choose that?
6. How did you choose the PD program content and method? Were there any changes made in the courses, and if so, why were they made?
7. Were the basic documents used helpful and useful in designing and developing this PD program? Is there anything you wish to be supplemented with?

Part 3. PD program developer → teacher
  1. How did the experience in PD program affect you when you got back to your original community?
  2. How did the survey in the preliminary course and PD feedback help you or used in any ways?
  3. How would you assess the whole process of the 2015 Reform Curriculum PD program? What were some difficulties you found?
  4. Are there any improvements needed in terms of dividing roles and cooperation in the course of PD program development?
  5. What improvements should be made on the PD program to have a more constructive effect on the community?
  6. What do you expect from or recommend to the future facilitators of this scaling-up PD program?

These questions lead the interviewees to lead their own ways to open up and tell the interviewer about their experiences in the PD program as a teacher and a PD program participant or a developer. Part 2 of each interview was to draw the experience of getting a new role as he or she participates in the program. Part 3 was to draw his or her experience in the reversal role change. The interviews were voice-recorded upon agreement in advance and fieldnotes on the gestures, facial expression and attitudes of the interviewees were made by the researcher.

4. Data Analysis

Since I am handling qualitative data as source for this research, method and process of data analysis for a qualitative research (Bogdan & Taylor, 1975: 79-94) was carefully revised in advance. The transcripts were read and compared with the fieldnotes and had another person read the same data for added check. By reading repetitively, important

conversation topics and key words were coded several times in order to construct typologies for significant findings of this research. Pertinent literature was read in order to support the hypothesis made by the defined codes. This research uses the qualitative content analysis approach which is a research method for making interpretation of qualitative data through systematic coding and identifying patterns (Hsieh & Shannon, 2005). The coding is reflexively made inductively, data-driven (Schreier, 2012:1-19) in order to enrichen the meaning of the data. In the data analysis, categories were formed by using repeated or key words from the data collected (Merriam, 2005). All interviews were transcribed into Korean first, which was the language of medium in the interview, and the Korean transcripts were analyzed in effort to counter dilution of the speakers' intention or meanings. When the speakers paused for more than two seconds or used fillers, the transcripts were written down as "…" for pauses and as the sounds made by the speakers such as "um" to mark the points where the speakers stop to think before they answer. Afterwards the interviews were translated into English to be inserted as excerpted in this research. The categories for coding can attend to either explicit or inferred content meaning of communications. Using qualitative analysis method can reveal phenomena that cannot be seen in quantitative research (Kwon, Park, Lim, & Heo, 1999). This analysis method follows the three core steps in the process: selecting the unit of analysis, creating categories, and establishing themes (Cho & Lee, 2014). For this research, all the transcript data collected from interviews and part of supplementary data will be used for analysis and create categories or themes based on related literature.

The analysis was made grounded on boundary theory (Leong et al., 2017; Akkerman & Bakker, 2011) with the focus on particular terms

and contents in the answers of research participants during their interviews. Research participants were laid in intersecting areas or boundaries through taking part in this PD program development and PD program. Boundary theory as in the previous section is the mechanism that explains how the ideas and knowledge shared and created in a newly formed community becomes in use when they get back to their originating communities.

In addition, using triangulation method which adopts several types of data sources for research, the data and analysis are revised by several researchers. The data collected were all revised by the researchers' supervisor and interviewees whose answers were used as the data for analysis. Interpretation and analysis of the data were also revised by colleagues in effort to avoid subjective interpretations.

IV. Data Analysis

In this chapter, the boundary encounters in this whole PD program project are identified by referring to the interview transcripts and written documents such as PD program project proposal, 2015 National Reform Curriculum subject curriculum documents, PD packet, meeting minutes and project reports.

In order to protect the identifications of the research participants, this research blinded most of the personal information on purpose. The teachers who became the PD program developers, more specifically PD package writers and facilitators, are classified as PD program developers and the teachers who are prospective PD course facilitators as PD program participants in this research. In this chapter, significant findings on the boundary encounters and the characteristics from the research participants' experiences of boundary crossings in the 2015 National Reform Curriculum PD program project will be described. Interview transcripts were analyzed and the excerpts were translated and annotated to provide more context to the relative pronouns and fragments in the answers of the research participants since they were casual talking.

1. Analysis of Boundary Encounters

PD programs provide an opportunity to discuss about the meanings between and within communities of research and teachers. In this sense every PD program which involves more than a single community of practice has the potential to discuss the meanings of the issues or topics being discussed and enrich them. The PD program project I am

referring to is the whole series from the development of the PD program to carrying out the PD courses and follow-up programs on the 2015 National Reform Curriculum.

In order to understand the micro-context of the elements of boundaries, one needs to understand the macro-context (Hermans and Kempen, 1993). The 2015 National Reform Curriculum PD program can be seen in two scales: the macro-context of different communities and the micro-context of different individuals. Hence before taking a closer look into the micro-context of the boundary crossings, I will look at the macro-context which are the boundary encounters where the boundary crossings occur. As Sztajn et al. (2014) has suggested, each boundary encounter is constituted of different elements, which can be described in terms of boundary brokers, boundary practices and boundary objects observed at different boundary encounters as in <Table 5>. For each boundary encounters identified in this PD program, the elements or constituents differ because of the setting and different phases throughout the course. These boundaries formed may affect the PD program itself, or especially in a scaling-up PD program since there are seemingly discontinuities that may help to expand the effects or sometimes hinder and break the growth.

<Table 5> Analysis of the boundary elements in the 2015 National Reform Curriculum PD program

Boundary Encounter	PD Program Development	PD Courses
Boundary Broker	– delegations of teachers – university professor – MOE administrator	– delegations of teachers – delegations of PD program developers
Boundary Practice	– PD program development meetings, reading, writing, revising	– understanding, discussions, Q&A
Boundary Object	– given artifacts: PD source book on common course Mathematics – produced artifacts: structure and schedule of PD program, PD packet (presentation slides and activity materials)	– given artifacts: PD packet, games, activity materials – produced artifacts: whole sheet poster, product of activities, ideas (nonconcrete)

The incidences of boundary encounters will be described in terms of when and in what form they occur. Also, the constituents of each boundary encounters will be described in this section to provide an answer the first research question: *What are the constituents of the boundary encounters in the 2015 National Reform Curriculum PD program project?*

1.1. Disparities

In this section, data analysis was carried out to depict the different

boundary encounters and their different constituents evident in the 2015 National Reform Curriculum PD program project. Sztajn et al. (2014) presented MPD program as one of the best places for exchanging knowledge from one's affiliating community and affecting each other, while their communities' importance and priorities remain the same. Likewise this PD program has provided a space where boundaries of individuals and groups are adjacent or even against to each other while developing and implementing the program. These two phases of PD program project was regarded as one lump of event until now. However, in this study, a large scale PD program was designed by a group of PD program developers, where the PD program development itself involved the professional development of "original" facilitators and research-designing the program. Hence the two phases in the process of the PD program project can be defined as following:

Phase 1: PD program development
Phase 2: PD courses

It is significant that during the different phases of PD program project, there are different boundary encounters that is formed by the different boundary elements. In this PD program project, boundary encounters appeared at two phases – development of PD program and enactment of PD program. Looking at the boundary encounters, different boundary brokers could be identified in forms of delegations in macro-contexts.

<Table 6> Boundary brokers at boundary encounters

Boundary Encounter	Boundary Brokers
PD Program Development	- delegations of teachers
	- University professor
	- MOE administrator
PD Courses	- delegations of teachers
	- delegations of PD program developers

From a macro-context perspective, a boundary encounter appeared during the PD program development (Phase 1) where the teacher delegation, researcher delegation and MOE administrator delegation met up for the PD program development. According to the different communities they are affiliated to, these *boundary brokers* involved in this PD program development expressed different perspectives on the values and weights of different topics or themes to be handled in the PD program regarding the new curriculum implementation. In the interview, teachers expressed that the disparity is visible in largely two groups, that is the MOE and the group of high school teachers.

> Interviewee 5: I think there was a <u>difference</u> in what we [teachers] want to deliver, and what the MOE wants to deliver in priority. (underline added by the author)

Interviewee 5's interview excerpt shows that disparity existed between the delegations of teachers and that of MOE in terms of their priority in this PD program. Meanwhile, in phase 2, disparities in different perspectives between delegations of PD program participants and PD program developers were evident in the PD programs as well. Facilitators of the PD were selected among PD developers and PD participants came to the site as representatives or leading teachers from their schools or districts. This boundary between facilitators and

participants were formed by their roles in the PD program and by the gap between expectations of the participants and the purpose of the PD program. Some teachers like Interviewee 13 held different expectations regarding the intents of the PD program. Unlike the established forms of most PD programs in Korea, where the PD program participants are "receivers" of the information being delivered, this PD program involved teachers to contribute to the PD. However, not every teacher enjoyed the discussion sessions and the lectures which handled only the core abstract of the new curriculum documents.

> Interviewee 13: So what the most ridiculous part was... they said... for example, in the changing curriculum, mensuration by parts is removed from definite integrals. The introduction part. Then they [facilitators] would just move on saying "think about this part". Basically, I wanted to hear about the methods that they had came up with using it [the changed curriculum], and that if I had used that method in my class, students would have understood it like this and that, and so on, but I was left to think about it on my own. So what? We [participants] were like what? And then, they gave us a whole paper, just gave us a whole paper and, for example for that I think subject courses gathered at once. When I did it then, wait, they emphasized this – curriculum-based assessment. I had heard about curriculum-based assessment but how is it different from performance assessment? Performing during classes is a curriculum [process] itself. Teachers [participants] said that too. What are we supposed to construct when we are just given a whole paper all of the sudden. We are not sure about this and the difference. You know, teacher groups complain about stuffs, but then they diligently construct things. We just talked about the performance assessments we carry out at each school and wrote it on the whole paper. I think the other groups did so too and stuck it on the wall and presented it – that was it. (underline added by the author)

In addition, Interviewee 13 had different interpretations of the new curriculum, mistaken that the teaching methods are not related to the

new curriculum. Despite the participant had said that she understood the new curriculum well because she had read over it several times, it seems from her interpretation that she had missed out on some of the essence of it.

1.2. Forming Mutual Understanding

Several different ideas is seen as a variety, but the ideas are not always in harmony when raw. Since the groups of PD program developers were coming from different communities, the collaboration of variety is expected to give a synergy effect on the program's content and quality. Interesting about this is that this amplified status mostly results from the changes made as the different ideas are discussed and their values are negotiated in boundary encounters. They constantly held discussions in groups in order to generate understanding about the purpose and the direction of the PD program.

<Table 7> Boundary practices at boundary encounters

Boundary Encounter	Boundary Practices
PD Program Development	- PD program development meetings, Reading, Writing, Revising
PD Courses	- understanding, discussions, Q&A

Endeavors to find resolutions and mutually accepted knowledge, the PD program development involved teacher-developers to discuss and generate ideas and knowledge in small groups and share it as a whole. In order for those in the boundary zone to cope with this new knowledge, often multi-faceted, one needs to experience this process through participation and crossing between boundaries (Tsui & Law,

2005). This boundary crossing involves boundary brokers to be engaged in boundary practices of various forms and places and to take stances of multiple communities.

Boundary practices in the PD program development were held in several units by topic course groups, subject groups, and inter-subject group in the form of meetings. Among the several meetings organized by SNUCITE (Kwon et al, 2017b: 12-14), three large meetings which invited PD program developers and MOE administrators of all four subjects involved in this large reform curriculum PD program project were held as the following schedule in <Table 8>.

<Table 8> Meeting agenda and contents from official documents

Meeting (Date)	Content
Prior consultation (2017.04.21.)	Project objective establishment and selection of facilitators and developers
First meeting (2017.06.03.)	PD program organization
Second meeting (2017.06.24.)	PD program organization and examine PD program package

Margalef & Roblin (2016)'s research findings highlighted that the facilitators must build close relationships with the professional learning communities and adapt to the needs of the community in a continuous mode. As mentioned earlier, this particular PD program was organized with the purpose to help teachers' understandings on the new curriculum. Over 500 high school mathematics teachers were recommended and selected as PD program participants, and they were provided with PD courses facilitated by PD program developers who are also high school mathematics teachers ordinarily. Hence the facilitators

could constantly move back and forth between their given role in the PD course as a facilitator and their original job as a teacher in order to notice any needs by the PD program participants. By introducing themselves by their affiliation, which would be a high school name, they formed closer relationships as teachers. Consequently, despite organizing and leading discussions and providing relevant resources and feedback in the courses, they could avoid the image of distinguishing themselves as experts from groups of teachers.

Since both the facilitators and participants were teachers, there was a mutual understanding that there is not a better way than to discuss about the future practices that are desirable in the new curriculum. PD participants in the group of five to six put their head together to think about lessons or activities that pursue the idea of the 2015 National Reform Curriculum in activities in PD courses. The teachers were given time to experience themselves on the new curriculum in facilitation of the PD facilitator.

1.3. Concretizing and Contextualizing

When the boundary brokers are engaged in boundary practices and boundary crossings, they also use and produce artifacts which are *boundary objects*. The artifacts can be identified in terms of its roles in the boundary encounters; either given as a means to boundary crossings or as a product of boundary crossings. These characteristics will be discussed in more depth later on in Section 3. Also, artifacts may be in concrete or nonconcrete form but only the concrete forms can be observed from an outsider's view. Only when the participating boundary broker shares his or her changes or new formations in thoughts may the nonconcrete form be recorded.

<Table 9> Boundary objects at boundary encounters

Boundary Encounters	Boundary Objects
PD Program Development	- given artifacts: PD source book on common course Mathematics - produced artifacts: structure and schedule of PD program, PD packet (presentation slides and activity materials)
PD Courses	- given artifacts: PD packet, games, activity materials - produced artifacts: whole sheet poster, product of activities, ideas (nonconcrete)

When discussing about teachers as researchers, Jaworski (2011) distinguished teachers by either those who use their own classroom practices to investigate with a group of teacher educator or university research groups in a research program or who are research initiatives designing everything in the research. However, since this PD program had many or mostly teachers in the group of PD program developers acting out both roles as a designer as well as a teacher investigator, it is difficult to make a clear distinction or make a single definition of their roles in the research. Similar to Huang and Bao (2006)'s Keli approach, this PD program, especially its contents and resources, was developed by the cooperation of professors, doctorates, doctorate candidates, and teachers. The process of the PD program development was also partly similar to the Keli approach, which is constituted by three stages, in that it includes writing up explanations on classroom practices as documents that is to be shared publicly. Not only was the PD program producing artifacts during the courses, but also in the developing stages. The PD program developers had to negotiate on the

educational contents and write up a PD packet that includes exemplary summaries and examples of the 2015 National Reform Curriculum to be used in the onsite courses.

Developing the packet or writing up the source book for PD program on the new curriculum is similar to writing a textbook in regard of the publicity and common goods aspects. Textbook writers do not work originally by individual purposes but rather are demanded to fully realize the intention of curriculum documents. Lee (2005) explained this by referring their job as being more like a 'commentator' or a 'producer' than a 'creator.' Likewise, choosing the appropriate contents to be adopted in the PD program and producing examples of contextualized knowledge is not solely done by the PD program developers. They are given guidelines from the MOE that they need to follow when carrying out their job task. Nevertheless, descriptions and contents are written by pretty much being dependent on the curriculum literacy and interpretations of these writers. The writing job begins from reading the given official curriculum documents and then goes on to unveil the ambiguity by contextualization of the knowledge through the writers' interpretation.

> Interviewee 6:   First of all, when we were developing the PD packet, teachers gathered together to develop this and revised it. MOE and administrators, and other teachers who have a lot of experience, such as master teachers, were asked to revise this packet.

Despite the PD packet was firstly written by teachers, the final packet was a revised version by the many boundary brokers in Phase 1. Through this process, the packet could be checked and supplemented by the boundary brokers of different originating communities at the boundary encounter.

Interviewee 4:   To begin with what was difficult, we had to guide teachers on what's new about the teaching and learning method. Not only the current methods but also the newly changed ones, for example, as I have already mentioned, we don't have any preceding examples in introducing definite integrals like that before. It was not easy to establish such examples one by one, and we did suggest examples on the curriculum-based assessment but it is not practiced in the field that it was not easy to make such examples.

Especially, in Phase 2, PD program participants working in groups have produced posters in the whole sheet activity, where they were given tasks by the PD facilitators to discuss about a topic or an issue. A few examples are presented in the report by the SNUCITE (Kwon et al., 2017b). By these activities, teachers were making artifacts themselves in the PD program and had the chance to share and exchange their ideas with others via short presentations.

2. Analysis of Boundary Elements

Earlier on, this research explained how the teacher participants in the PD program had the role and mission to give scaling-up PD programs led by MPOEs as a consequential project of this particular one. "Teachers are influenced by educational administration and policy, scientific community, and the multipliers" (Krainer, 2015). Multipliers in this PD program are teachers who were once participants of the original PD program. In this section, I will describe the characteristics of the boundary elements in terms of boundary brokers, boundary objects, and boundary practices in the PD program categorized and evidenced by the research participants' answers. This will target to answer to the second research question: *What are the characteristics*

of boundary elements in the 2015 National Reform Curriculum PD program project?

2.1. Characteristics of Boundary Brokers

During the almost year-long period of the PD program project, the PD program developers put in lots of time and effort, and everything from their personal experience into the PD program. Also, the PD program participants who have completed the PD program and is qualified as a scaling-up PD facilitator has already attempted to or planned for enacting what they have been acquainted with through the courses. Both the PD program developers and participants were holding responsibility that they should change themselves in order to make a difference in the teachers who are participating in the PD program. The PD program developers who were the boundary brokers of the boundary encounter in the course of PD program development showed the four common characteristics such as comprehending, reflecting, negotiable, and motivating.

2.1.1. Comprehending

The characteristic of *comprehending* can be defined as reading texts and understanding ideas that one becomes in contact of. Not only does it mean to read off the words written in documents, handouts and books, but it means to understand the underlying meanings and ideas that it is trying to convey to the readers. In addition, while the boundary brokers interact with each other, they try to share their ideas in order to convince others or develop them. From those who become the receivers of these ideas, they are not just receiving them

passively, but understanding the background and direction of the ideas and taking part in enrichening or improving them.

The PD program developers themselves began by reading the given, announced official curriculum documents and the source book of one topic course, Mathematics, developed in the previous year's PD program. Through this process, they summarized and wrote up examples for their assigned parts in the courses of this PD program. At the meetings, where they shared their difficulties in their working progress, they brought in with them the proposal of educational contents for this PD program they made, discussed, examined and selected suitable contents among them to be put into the PD program packet and used during the PD courses. By reading the official document on the 2015 National Reform Curriculum, the PD program developers selected the priority knowledge to be covered in the PD courses and made a summary on it with their developed examples.

> Interviewee 4: First of all, the educational contents and methods for the PD program were also chosen by discussions among people within the Mathematics II and Calculus course teams on what and how contents will be studied. There was already a large frame set to explain largely on the changed contents that is presented in the curriculum document; achievement standards in Mathematics as a whole, how they have changed, how the teaching and learning changed, how assessment has been changed.

From a qualitative analysis on the interview transcripts of curriculum developers, Park (2016) had concluded that the subject curriculum must reflect the trajectory and intent of the General National Curriculum, which encompasses separate subject curriculums, in order to be able to say that the national curriculum is fully serving its role. Teachers found this PD program helpful in understanding the backgrounds and needs for the new curriculum and its intent which made them trust it.

Interviewee 10: I became to trust the curriculum at some point. I became trustful of the new curriculum since I am looking at the change from a view that perceives the change to be a process to become better. I am <u>able to understand and accept the intents</u> to a certain point and so I am very trustful of it. If the curriculum reform was made without knowing anything... I would think why the changes are being made when it is already good enough. To be honest, I thought that everything is allocated well, [by going through] one by one, what is being taken out, added, or moved; how and why the changes are made. (underline added by the author)

Interviewee 18: <u>I felt the need, the imperativeness of the curriculum reform.</u> Before participating in the PD program, I thought it [curriculum] changes randomly in a few years period, too often, when the government changes. After taking this PD program, since I became to understand why this curriculum has been announced and the needs for it, I could concentrate on the PD courses and deliver it without much difficulty in the process of delivering it. (underline added by the author)

Understanding the intents of the new curriculum, is important in giving scaling-up PD programs, since the core idea and essentials should not be distorted as mentioned earlier in the didactic transposition of knowledge. Teacher participants had to continuously think about their role changes while taking the PD courses themselves.

Interviewee 19: From the largest frame, the General Curriculum. Things like 'Why do the classes need to go in this direction?' This is a world tendency. There are conditions for why the classes need to be this way in Korea too. There is a need to appeal this part. Conditions are made that something taught and memorized cannot be called a discipline, but still are learning ad memorizing. I put my focus on the appropriateness. The bits and pieces are parts where I need to study myself and apply to the class. Yes, I focused on that.

Interviewee 18: I am in the position not just to take to the training but to deliver

a scaling-up PD afterwards. So I need to know the meanings without missing any parts, right? So I tried to take the PD program thinking about my role as a educator who will be teaching onwards as well as an educatee. (...) Well, there are changes in the General Curriculum and so, but I focused on the specific parts, such as the Mathematics subject had changes in the organization of contents of this and that. I tried to focus more on those parts.

Interviewee 11: I was looking at the 2015 National Reform Curriculum from a very negative perspective and I had a lot of doubt on the selective curriculum being really helpful to students as a result. Through the PD program, I had a chance to look at it from a more positive perspective by understanding that the large structure has not changed so much from the current curriculum.

Despite the negative connotation of the new curriculum, the teacher was able to reform her image of the introduction of the new curriculum. This is important since the teachers need to be convinced themselves that the changes presented in the new curriculum is necessary in order to deliver the message to others.

There were teachers who were confident that they had understood the purpose of this PD program and about their duty to serve as scaling-up PD facilitators. After having participated in the PD program, they found that a lot is changing in the national curriculum in term of the naming of courses and the order of the corresponding contents, as well as the desired classroom practices. They had felt this emphasis and focus of the PD program they were provided with, which were also the focus when the PD packet was developed.

Interviewee 9: Firstly, since this is the lead teacher PD program, the 2015 National Reform Curriculum is like this... and such... what became different and what the focuses are were taught and told us to deliver. The reason why I thought so is that, from what I heard, I think the PD program was carried out with a focus on these.

Interviewee 12: To me, it seemed like <u>a lot is being changed. The names of the courses are changed a lot.. and the order in which they are presented, the teaching methods had changes..</u> and so I thought that this PD program was carried out in regards to the changes needed about student teaching methods and how students perceive this at school. (underline added by the author)

Interviewee 18 went on and talked about his in-depth understandings of the new curriculum, which in fact is mirroring the projection of it. The new curriculum enactment aims to relieve the burden of mathematical learning and emphasizing to touch the affective domains of the learners. In addition, education is calling for creativity not only mastering a large amount of contents.

Interviewee 18: If you look at the contents of mathematics, it is widespread that the focus of mathematics classrooms should be student-involving and curriculum-based assessment than outcome-based evaluation. Hence I became to think that education is heading towards thinking about creativity and decreasing *Soopoja* [meaning students given up on math]. As written in the reform curriculum, the PD program fully explained this. Yes, that's right. I believe the purpose of the PD program has been achieved.

As boundary brokers, teachers were trying to read between the lines of the text and understand the PD courses facilitated by some other teachers, who were involved in developing the whole course. Those who had already given the scaling-up PD courses, Interviewee 18 and Interviewee 13, were very confident about their understandings since they had looked in depth on the PD packet and preliminary courses they were provided with for several times. As the PD facilitators had to read the curriculum documents line by line in order to contextualize the meanings, the scaling-up PD facilitators had to read between the lines of the PD packet in order to modify it for appropriate use in

their own district communities. Keeping in mind the fragility of knowledge, the boundary brokers had to develop skills to comprehend the texts correctly.

2.1.2. Reflecting

I have explained earlier that all boundary brokers in this research had to serve at least two different roles or identities in this PD program. By *reflecting*, the boundary brokers were referring to their role as a teacher in ordinary cases and their experiences of participating in PD programs in the past. Reflecting enabled to constantly be engaged in the action of boundary crossings at the boundaries. The PD program developers as well as the PD program participants reflected on their experiences as a teacher in the field.

The PD program developers, who are the boundary brokers of the boundary encounter at Phase 1, formed smaller teams of three or four, each of the team was in charge of one of the four topic courses covered in the onsite PD course. The developers had chosen topic courses according to their research interest and had brought in about their original concerns as teachers.

> Interviewee 4: The reason I chose Mathematics Ⅱ is that the chapter on Calculus is in Mathematics Ⅱ. In the previous curriculum, integrals were found using mensuration by parts, but this is taken out and I wanted to find out more about on how to effectively accept and deliver the definition without it in the field, which was a <u>concern I ordinarily had</u>. (underline added by the author)

Coming to think about the role of this PD program, not only does it provide a place for teachers to gather around from different districts but it has a goal to improve teachers' understanding on the new

curriculum. One of the PD program developers made a positive comment on the purpose of this PD program being carried out referring back to his experience as a teacher.

> Interviewee 6: I heard that the purpose of this PD program was to deliver to teachers how the curriculum has changed focusing on the teaching and learning methods, which I thought is very good and important. In reality, when the curriculum changes, the teaching and learning method also changes, but a lot of teachers are uninterested about this and just teach the way they want to. Because of this, it was necessary to explain what has been changed one by one and what the intentions are through PD programs like this. It was very nice that this PD program was thrown, the purpose is very good.

All of the PD program developers always kept in mind that the PD program is "for" the teachers who will be teaching high school students in the following year when the new curriculum is enacted. Hence they made approaches that can be easily understood and feasible in classrooms.

> Interviewee 4: I came to think, for example, we had our focus on the methods of <u>classroom practice in reality</u>, while the MOE had laid their focus on the changes of achievement standards. (underline added by the author)

As described earlier on, the PD program developers were mostly teachers, who are teaching classes to implement and realize the intended curriculum in reality. Especially teachers who were involved in the PD program project as developers kept referring to their original community of practice as a teacher. Constantly moving back and forth, the teachers intervened between the two communities by crossing the boundaries. The results of this boundary crossing is written in text in the PD packet.

> Interviewee 4: I think my thoughts about teaching and learning methods ordinarily had influenced because I tried to talk more about teaching and learning methods during the PD program as a teacher. This influenced while developing the PD program.

The developers themselves found this PD program to be reflecting what is really wanted and needed in the field because most of themselves were currently teaching in schools. Here are two excerpts that describes the boundary crossings made by the groups of developers.

> Interviewee 4: Having many teachers involved played an important role, since classroom practice needs to be done in reality. What are the difficulties I face when I teach? <u>What would I want if I were to receive this PD course? I went over these questions at least once as my concern.</u> (underline added by the author)

> Interviewee 1: I am not sure if it is because there were a lot of teachers in the PD program developer group, but I have a feeling that the PD program <u>reflected the needs of teachers in field.</u> (underline added by the author)

Since the new curriculum put emphasis on the changes in the teaching and learning methods in classrooms, the PD program developers tried to provide an example of each topic covered so that the teachers have something more concrete to discuss on rather than being just given a summary of the abstract curriculum documents. The PD packet writing involves the authors to go through a phase of experiencing the stances of PD course providers as facilitators as well as that of PD program participants who are teachers. As mentioned earlier in the review of related literature, the PD program developers had to go through concretization processes when organizing and producing the PD program package. The fact that the developers are currently teaching at schools helped them understand the expectation and needs of their PD program

participants who are also teachers, but then when coming to think about the facilitators' stance, they had to consider what content is pedagogically appropriate for the PD courses.

This PD program was special in that the facilitators were all currently teaching at schools while most PD programs on the curriculum or scaling-up PD programs were lectures given by the junior school supervisors. Having teachers as facilitators was an advantage in that teacher participants could easily refer to their own classroom practices as well as the lecturers giving examples of their own practices relating to the new curriculum. Doing what is already there in text source wears off the effectiveness.

> Interviewee 19: But this time, it was not the school inspectors from MPOE but teachers from all across the country, like so. It did change a little. It was different that we will experience what was experienced for real. They chose samples of people [facilitators who are teachers] who really investigated what will changed. Before this, only transmissive PD programs were carried out which does not have many meanings. Yeah... Doing such transmissive PD programs by PPT [presentations] decreases the effect.

However, when coming to think about scaling-up PD programs the teacher participants had to carry out, they were worried about how to implement their memorable experience into the future PD programs. Despite the participant feels that discussing and sharing concerns on a topic is distinctive from just asking to make a lesson plan, referring to their past experiences in scaling-up PD programs, such activities are hard to be adopted into scaling-up PD programs in reality.

> Interviewee 9: [For my scaling-up PD program] As I have already said that I liked, discussing and thinking about issues together were more of the actual concerns [that I wanted to handle]. For example, I thought it is different to say 'let's make a teaching and learning scenario' from [just] saying

'something was taken about from the curriculum', but I became to think about the reality concerns that it is difficult to carry out when I get back to school as a scaling-up PD facilitator.

The fact that scaling-up PD programs commonly allow much shorter time slots than the original PD program has been a crucial point of this concern. Time constraint consequently require the scaling-up facilitators to reconstruct the content and organization of the PD program suitable for the new conditions. This reorganization of the PD program into a scaling-up PD program turns out to be a compact summary of the original, often leading the job of the facilitator to turn out as lecturing - a lecturer.

Some even complained about the duty to serve a scaling-up PD course because of the insufficient number of examples they were given to adopt. However, Interviewee 13 soon understood that the new curriculum has not yet been enacted in the classrooms, hence it is not an easy job to say how and what to teach in the classrooms.

Interviewee 13: There cannot be any examples, because it is before enactment.. So probably it is the first time that the lecturers [facilitators] are doing this. I think that Probability and Statistics teacher [facilitator] showed what he had tried. The Geometry and Vectors teacher [facilitator] also, the three dimension, explained how the class was taught using that in the class. I think that touched the teachers instead. This [curriculum] has not been enacted yet and we don't have any experience, and so, as a teacher, as these teachers [facilitators] are also high school teachers, I would been the same to do something about this if I were in their position. I would have just said, "so think about it" and move on. That's probably why they followed what they are currently doing. I totally understand their stance.

When switching roles, teachers mostly compared and referred to another identity by reflecting on their daily experience as a teacher. PD program developers could focus on the needs of teachers as well

as themselves. Through emotions of sympathy, PD program participants brokers able to prepare for and reflect the needs of the community of teachers in their either carried out or planned PD courses. After three months past the PD courses, the PD program developers and participants had gathered for follow-up discussions on the PD program. All those who participated in the follow-up meeting agreed on how this PD program was a noble start on the new form of "participating" PD program and what parts should be reinforced.

The new curriculum has many newly introduced contents in terms of the direction of the curriculum construct, administration and scheduling of the curriculum. Each section was added by descriptions to concretize the abstract idea of the national curriculum. The first section includes descriptions on the ideal figures, focus of the curriculum construct, and educational goals by grade groups, and the second on the administration and scheduling of the curriculum in general, teaching and learning, and assessment (Kwon et al., 2017a: 5). The PD source book was written in collaboration of teachers and researchers trying to reflect the concerns and practical needs of teachers in the field.

Examples for elective courses
1. Examples of application of the changed achievement standards and key terms
2. Examples of application of the changed teaching and learning methods and note
3. Examples of application of the assessment and note
   a. Examples of should-not-be handled
   b. Examples of curriculum and competency-based assessment
(Kwon et al., 2017a)

Teachers who signed up for the follow-up meeting after the project outcome briefing could request discussion topics and the topics that were turned in are (1) practical enactment of curriculum, (2)

curriculum-based assessment, and (3) applied mathematics. The facilitator of the follow-up meeting also prepared a short 20-minutes lecture for the participants in a Q&A form – easy and straight-forward – reflecting on her past experiences as participating in this PD project as well as other PD programs.

Providing teachers with the opportunities to reflect on personal experience is crucial in professional development regarding classroom practices (Farmer, Gerretson, & Lassak, 2003; Zaslavsky & Leikin, 2004), and this is most likely to happen when teachers really go through a new learning experience. By becoming exposed to some authentic hands-on activity and gathering different experiences of many teachers naturally lead to reflect on their own instructional practices and inquire if there is a room for change or need for sustainment.

2.1.3. Negotiable

Boundary brokers also were very *negotiable* in terms of sharing and bringing in ideas for supplementation and improvements. A boundary broker would take in ideas of different perspective and collaborate with other boundary brokers and their ideas. The group of developers constituted of researchers, teachers, and research teachers, each of whom have different job experience in different schools and research experience. Moreover, since the teachers in the group of PD program developers have these different experiences from their jobs or schools, they had not the same perspective in the beginning when developing the PD program packet.

> Interviewee 4:   Yes, I think there were <u>differences</u> in perspectives; for instance, how the MOE looks at the PD program textbook, and how the master teachers look at what I have developed. (underline added by the author)

Moreover, pointed out that most PD programs are developed in pieces and parts separately, giving an image that the purpose or direction of the PD program or project is not shared nor have been made in a consensus among the lecturers and people involved in the development. However, boundary practices in the forms of group discussions and cooperation in small and large groups were carried out often in this PD program project. These practices involved investigations and decision makings such as developing examples and choosing the educational contents for the PD program.

> Interviewee 1:　 I think many PD programs, there are many PD programs in which the different lecturers have not shared what the PD program's goals and directions are. In many of them, they [lecturers] are given their own course topic and prepare the different topics separately and carry out the lectures. I am not sure if PD programs on curriculum are like that, but I think it is that way in most PD programs.

Meetings of mathematics subject group as a whole were also held on the same dates as in <Table 8> when the inter-subject meetings were held. An excerpt from an interview with Interviewee 2 mentions that despite there is no improvements needed, it would have been better if the difficulties and how to cope those difficulties could be shared as in her own group.

> Interviewee 2:　 For example, Mathematics, I think it would have been better if the difficulties each mathematics groups are facing had been shared and how they are coping with them since we did not know about them. Um… Mathematics II and Calculus teams were well organized in terms of each person's roles and I thought it was good to do it this way. I don't think there is any improvements needed.

The cascade PD program participants, or the future facilitators, were

flexible at adopting and changing their practices by what they have been provided with and have experienced. As described earlier in the PD program development, while most other domestic PD programs use lectures as their main medium for proliferation of knowledge, going in one-direction in the manner of top to bottom, this PD program had intentionally avoided this from its design and the participants had found this attempt appealing. The PD program participants commented on this curriculum PD program making comparison with other PD programs that they have attended before. Mostly said that the typical PD programs are carried out in lecture forms, where there is one or a group of lecturers who give a talk or a summary on the topic they are covering in the course. However, in this PD program, facilitators were doing more than just lecturing and delivering the PD content; they were organizing group discussions as well as giving short lectures on the course topic.

> Interviewee 12: It was a bit <u>better</u> than other PD programs. It was <u>more meaningful</u> than other PD programs, and... what is there for improvement? Um... It was the first time for me to take a PD programs that lasts 1 night 2 days. Mostly it was always three to four hours. Um... and I really liked that I could talk a lot with experienced teachers, experience and take classes together. (underline added by the author)

> Interviewee 19: This time, what was <u>different</u> was that, teachers who have investigated a lot had given us more time to experience. In the past, we got scaling-up PD programs to give another scaling-up PD program, but this time we had more time to experience and sympathize it, and gave a scaling-up PD program after experiencing it. That was not even once, but [we had that] from the MOE, and another from the MPOE, and then I gave the scaling-up PD program. (underline added by the author)

The most meaningful, memorable part of this PD program that the PD program participants agreed upon was that the participants really

"participated" and were engaged in the PD program. Participation was made mainly in forms of discussion and group activities. For instance, the PD program participants were engaged in making lesson plans or classroom activities in groups and doing group games and quizzes.

> Interviewee 11: Especially, I liked that I had a chance to discuss and share [ideas] in terms of curriculum-based assessment with many other teachers.

As the new curriculum emphasizes student-involvement as a significant classroom practice, the PD program on this new curriculum tried to follow the moto so that the teachers could experience it themselves. The positive feedback on this particular organization of the PD program shows evidence that the intention of the PD program was fully realized and achieved, and at the same time proves that this method is effective and advantageous as a teaching and learning method. PD participants who were interviewed found this method effective and open to adopt this method and changing their own practices in classrooms.

Also discussions in or between subject groups had talked about how one change will affect another in the subject curriculum as a whole. By discussing between different subjects handled, the developers, or teachers in nature, thought about the interrelations of different subjects within mathematics since there were also changes in the mathematical concepts covered as well as the order they were presented in.

> Interviewee 4: I really liked the process of PD program development. We were regrouped into smaller teams in the mathematics subject. Probability and Statistics, Mathematics II and Calculus and so on, and then there were several meetings held within these groups. I am not sure if it is only for Mathematics II and Calculus, but I really liked that we could discuss on how to connect these together by (for instance) how a change in

Mathematics Ⅱ will affect Calculus. <u>Discussion among related subjects? The connected discussions was very nice.</u> (underline added by the author)

Moreover, having discussions as a whole with the teacher MOE administration, head teachers and revisors were complementing in terms of richness and direction of the PD program and its textbook. Despite the resolution was not to create a whole new collective knowledge but to add some knowledge to complement the ideas of both parties, they produced a textbook of collaboration and consensus.

> Interviewee 4: They (the revisors) gave us many comments, but they were not trying to change our opinions but playing a <u>supplementing role by adding a little bit onto the direction we were heading towards.</u> (underline added by the author)

> Interviewee 3: We tried to follow and reflect the curriculum documents to the most.

Still, Interviewee 3 said that the organization of the packet is not totally new and it took in the MOE's suggestion to relate it to the curriculum documents as much as possible to avoid loss of meaning and context. The consequently produced PD packet after this course of discussions and mediations was provided with the following organization:

Ⅰ Main contents of the 2015 National Reform Curriculum
Ⅱ Changes in the achievement standards and key terms
Ⅲ Changes in teaching and learning methods and note
Ⅳ Assessment and note
(PD packet p. 123-178)

In "PART 5: Discussion and Understandings on selective courses in 2015 National Reform Curriculum high school mathematics" of the PD packet, contents were presented in terms of the six courses in high

school mathematics. The headings under each course in the PD package consisted of four parts. The content organization was also decided as a consensus of discussions in the boundary practices.

2.1.4. Motivating

Motivating might be difficult to see its effect straight away, since it is about making changes in others by influencing them with one's own ideas. Boundary brokers not only listen but speak up for themselves and their communities, which will in turn be considered for negotiation with other boundary brokers. PD programs with this purpose seem to be of need because not many know how exactly the new curriculum has changed despite of the interest many teachers have and the mass media project this issue. The ambiguity of the curriculum documents is not solved and not many official documents at school are relating to the curriculum.

> Interviewee 10: Teachers are interested about the TO [table of organization] a little bit, and when teachers gather to talk about this, there isn't anyone who is definitely sure about how the curriculum is like. [Although] they are very interested... So we just organize how we are going to do this by referring to examples of practice of some other schools nearby. ... There aren't many official documents regarding curriculum that come through. No, the only one that came was this PD; training a few selected teachers. This is about it. (underline added by the author)

Kieren, Krainer, and Shaughnessy (2012) argued that teachers hold the highest potentials to improve student learning and reform education, therefore should cooperate with everyone so that they can form a common goal. Research community has potentially useful knowledge in teaching and teachers have knowledge about students in the school

classroom context, and the exchange of these knowledge can be made through PD programs (Sztajn et al., 2014). In this research, PD program developers were all teachers except for two of them and everyone had two perspectives or two stances when working towards this PD program development; one as their original job as a teacher and another as a PD program developer.

It is a fact that the curriculum documents are huge in terms of lengths and takes a lot of time and effort to read and comprehend them. The PD program was constructed in the sequence of taking the preliminary PD courses, which consisted of a series of videos and short written tasks, then continued on by the onsite PD course where teachers gathered to listen to lectures and go into groups for discussions. Teachers found these series of video and short written tasks to be completed in advance of the onsite PD course very helpful in making themselves better understood of the curriculum.

> Interviewee 18: Listening to the preliminary lectures and then gathering to take the onsite assembly lectures was better. [The purpose was] accomplished. Since the amount of content of the reform curriculum is huge, teachers sometimes miss the content when the onsite PD programs are carried out. But they had to take the preliminary course and then take the onsite course again like this, so they had heard of it twice which, I think, made them participate more in the PD program. Listening to it once is done like that, but taking the course online helped me. I really liked that. As I have already said, without any preparation, it would be just over by saying 'I don't know, it's difficult because I sat in without any preparation on [the question] 'how has the reform curriculum changed?' Through the preliminary course, [it is explained that] the curriculum became so and I took the course again because I had to hand in assignments, and through this process I could focus on the weak parts at the onsite PD course, so I could take the course responsibly.

> Interviewee 19: Well... I liked that I had to take the preliminary course which was compactly summarized, and then, ah! I felt that I should do better when I

felt 'that person is way better than I am' as the experts give the PD program.

In Korea, teachers are too busy teaching and doing administrative work as part of their job that it is burdensome to sit and take PD courses that do not coincide with their needs. The teacher in the following excerpt expressed that preliminary course is much more effective in terms of time and proliferating the educational contents.

> Interviewee 13: I liked that way more. The preliminary course was listening [lectures] via Internet. I had a lot more to learn from that. ... The preliminary course was really well made being very specific on the needed large frame, knowledge to us.

Many of the interviewers found this preliminary course part of the PD program memorable and helpful in making themselves better understood. Such supportive environment seem to have motivated teachers to better understand and become more interested about the new curriculum.

Despite the research participants had mentioned that not all of them knew about their completion of the PD program meant the qualification of facilitating scaling-up PD programs, they had thought about serving the facilitating job since they found out when they got to the onsite PD course. When doing so, they tended to refer to the PD program they were provided with. The participants freely offered their opinions or were asked to freely describe what they liked about the PD program they had just completed and thought that will help them in their practice as a facilitator. The facilitators had motivated and turned PD participants from being the perceived "listener" into an active participant of the scaling-up of the new curriculum.

All teachers involved in this PD have a "dual role" in that

while they are teachers at schools, they become PD developers or lecturers themselves in the scaling-up PD courses supported by the MPOEs to guide after participating in the curriculum PD program as interactive learners. Teachers were motivated and trying to absorb the practice shared or suggested in regard of the new curriculum by the PD program facilitators who are teaching students at schools ordinarily. Concerns refer to how one could implement or incorporate the methods and materials into their own classrooms.

> Interviewee 13: Something other than the 2015 Reform... When I go there, I tend to listen closely to the things related to [the question] 'how can I use that in my classroom?' So when I look at those things, they look very okay, and it would be nice to incorporate that to show the kids... (underline added by the author)

> Interviewee 12: I have participated in PD programs, but had not many ideas that I found of much impact. But it was a bit interesting there [PD program onsite]. I thought 'that is interesting' if I teach the class like that. Simple and easy to apply to the kids. The class would be more interesting. So, to be honest, I saw mathematics magic and whatsoever at another PD program, but it was not really related to the mathematics we do in classrooms and it was just for fun. But here, making a three dimensional space using paper, students can see the three dimensional space themselves. Also Probability and Statistics that can use classes; I can ask the students, what is the probability of this when we do random drawings? I liked those that can be put into the classes.

Even if she expressed her unsatisfaction saying that the methods of practice has nothing to do with the new curriculum, she has been motivated to use the presented teaching method in class that she had already tried it out in her class when she got back to school.

> Interviewee 13: Yes. By teaching, in class, for example when students first start the chapter on statistics, when we do [calculate] mean, standard deviation,

and so on, there might be a mean error. This teacher [facilitator] showed us a video clip from the <*Jisik Channel e*> (direct translation would be Knowledge channel e, a program run by the Educational Broadcasting System) to show us the mean error, if the sample is small or large, and how the data can go wrong by who is being sampled – that was rather a big help for me. So I downloaded the resource. I am teaching statistics right now. It helped me a lot. I have used it in my class. The class material was so well-made. He used the Powerpoint, showed us something like the mean error, then the Powerpoint connects to the *Jisik Channel e*. Yes, the teachers [facilitators] made it public for use. That was rather helpful. In the form that can be used in class. Yeap, I teach Grade 2, 3 (high school grades; corresponding to Grade 11, 12), and Grade 3 is already finished their course, but Grade 2 listened to it very interestingly.

While Interviewee 13 had thought that creative methods of classroom practice is not related to the 2015 National Reform Curriculum, it is not so in reality. Since the PD program had one of its objectives in growing competency of teachers in the teaching methods in response to the introduction of a typical society of the new curriculum, giving PD program participants with ideas and insights can be seen that they were going in the same direction.

Interviewee 10: [I think we] affected each other. I don't have much work experience and.. the kids [students] don't listen to me, so my class is somewhat becoming a lecture. So, I try not to lecture the class but mostly become so. There were teachers from nearby schools and the student levels seems similar, but they were still concerned about experiencing and such direction other than lectures. I was very stimulated in that aspect. The teacher had quite a lot of job experience but still hasn't given up and is keep trying, thinking about 'how to approach an idea and what is the underlying thought?', experiencing and so forth. I had my hands off for a while, since the kids won't do it even if they are told to do so. I was stimulated about those things. (underline added by the author)

Interviewee 10 talked about how he had been motivated to think more

about how to carry out classroom practices that are not taken up by lecture-only because of his group members. Interviewee 10 had been struck by how teachers with much more experienced has a bigger hope than he holds. His group had shared different types of classroom practices and teaching methods they carry out at schools. Here is an excerpt where he talked about his contribution to his group.

> Interviewee 10: A while ago, um…, until last year, what I did a lot was, I connected the class with games. I thought that the kids would do mathematics like games if math classes were connected to games since they like games. Quests… Giving them problems and if they carry out a quest, they will move up a level and so on. Or… ah! they were very interested in that, they were interested in new devices or softwares, so I think a lot about 'how can I connect those to class?' This time, what was discussed was, on Youtube, a teacher had a class designed or so using games; using building blocks or assembling blocks to make three-dimensional figures. You know, when we do IQ tests, they show us a figure seen from above, from the left, [and ask] 'what is the figure?', we do these things a lot. There was this. I got the idea from that and talked about how to build blocks [when the idea is] applied to continuity of series and continuity of functions in order to learn the difference between building continuously and discontinuously. They all liked it and found it novel. I attributed like that.

One way to see if the PD program was successful in reaching its goals, the goals may be asked to the participants to see if they had caught the underlying intentions of the PD program. Interviewee 11 has described that this PD was supported and organized with a guess that teachers would not have enough time and energy to look up and study about it individually and also in order to make the implementation effective and go in the right direction.

> Interviewee 11: I think this PD program was carried out, taking into consideration of how teachers at school do not have the time or energy to look up

about the newly changed curriculum, with the purpose to smoothen the understanding and implementation of this newly reformed, enormously changed 2015 National Reform Curriculum.

> Interviewee 18: I think teachers [in the scaling-up PD program] could form a bond of sympathy with me because I could appeal to them about the motives of the curriculum reform, since I had been trained as a transmitter [scaling-up PD program facilitator] and the reform curriculum came out at a period where it is really needed.

Also, Interviewee 18 talked about how his participation in the PD course helped him better understand of this new curriculum as well as explain the intents and background of its appearance to his scaling-up PD community, he could form mutual understanding. In this particular boundary encounter, group discussions were used as boundary practices as well as boundary objects because the conversations that teachers had did not necessarily be all written down or recorded in any forms. Rather it is now in parts of the participants memories to recall on it and adapt the ideas in reality.

> Interviewee 13: I liked the, the organization itself. And how <u>teachers</u> for each subject came to give the PD program for each PD subject courses, that I liked. (underline added by the author)

Especially, having teachers who have rich experience in the subject helped teachers with richer second-hand experience during the PD programs. This will naturally give the participants with various situational interpretations as well as resources for classroom activities. This concrete ideas and teaching methods are not to be awaited until the new curriculum is enacted next year. In the meeting after all the PD programs were provided, Interviewee 14 talked about his experience of implementing what he came across newly in the PD program into

his classrooms.

> Interviewee 14: So what was nice about the PD program was that, there were four sessions on teaching methods in classrooms, I can't remember for sure how many courses there were, but they [teaching methods] were quite good when I tried a few of them. So now… I am thinking about buying the, that, the roulette that was used in the Probability and Statistics course for real classroom activity.

During the interview, Interviewee 14 kept mentioning how teachers onsite needs more teaching methods and classroom activities to be used directly. He was excited to find out more about these and talked about his plans on buying teaching materials for his classes. The teacher showed that he was ambitious to learn more about ideas on classroom activities and willing to participate in developing and implementing them into his classes.

2.2. Characteristics of Boundary Objects

In this section, the characteristics of the various boundary objects involved in the PD program will be identified. The interview transcripts and artifacts used and produced in the PD program will be analysed to induce what different characteristics they have. In addition, listening to the research participants' opinions, needs and expectations, the roles of the boundary objects has or will have will be explained. *Boundary object* could be identified in two forms: a medium of boundary crossing and its outcome via the boundary practices. When the boundary object is for the former purpose, it is providing, and transforming in the latter case.

2.2.1. Providing

The main purposes of this PD program was to support teachers better understand the main contents of the new curriculum and to reinforce competency in teaching-and-learning and assessment methods in order to foster integrative learners with creative competence. By providing the PD program participants with necessary contents that will work toward achieving the purpose of this PD program, they were given roles and missions to give scaling-up PD programs in their original community of practice.

　　　PD programs with this purpose seem to be of need because not many know how exactly the new curriculum has changed despite of the interest many teachers have and the mass media project this issue. The ambiguity of the curriculum documents is not solved and not many official documents at school are relating to the curriculum.

> Interviewee 10: Teachers are interested about the TO [table of organization] a little bit, and when teachers gather to talk about this, there isn't anyone who is definitely sure about how the curriculum is like. [Although] they are very interested... So we just organize how we are going to do this by referring to examples of practice of some other schools nearby. ... There aren't many official documents regarding curriculum that come through. No, the only one that came was this PD; training a few selected teachers.. This is about it. (underline added by the author)

Curriculum documents, especially the subject curriculum document, were emphasized when preparing for PD courses. Also a PD source book developed in the previous year was provided by the MOE to refer to as a guideline and set directions of this particular PD program packet they were working on. The source book was on the common course Mathematics, yet there were not any for other courses in mathematics.

These artifacts were serving as a medium of boundary crossings, *providing* information and guidelines for their PD program development. The boundary object being providing, shares the text form of the intended curriculum that is to be handled in the PD program. PD program developers found it helpful in setting directions and giving insights in brainstorming the contents.

> Interviewee 4: The most effective resource that I was provided with was… a source book that had teaching and learning methods by contents, chapters, and how it is expected to be taught commonly in the mathematics subject. I was told it is not yet developed for Mathematics II or Calculus. They (MOE) told us this is how the already developed course is like and to refer to this, so we can say they had presented us the direction of developing the PD source book.

However, the major challenge of scaling-up this PD program was that there was not any textbook published nor any teacher guidebooks on the changed curriculum. In the following excerpt, Interviewee 15 spoke up that the opportunity to share and discuss with many teachers in terms of curriculum-based assessment, given enough descriptions and examples on the changes from the current curriculum, was great but would have been better if some official resources were published instead of guessing on the changes.

> Interviewee 11: In each course, there were enough examples and appropriate explanations on the changed parts compared to the 2009 National Curriculum, which helped the understanding. … But it was pitiful that we could only guess the outcomes of the changes since there isn't any textbook or teachers' guidebooks published yet.

However, most of the PD participants felt the fact that there is no textbook is very user-unfriendly. Teachers were very reliant on the content of the textbooks when planning their classes in details and

hence mentioned that the PD program would have been more effective if it was carried out after having more concrete artifacts to be used in PD courses.

> Interviewee 10: Since they [MOE] said that [decisions on] the KSAT is not out yet, I wanted to get some overall information about it for them [students]. But I didn't have anything to get and even the lectures were like since 'there's no textbook out', they were facilitated like 'let's think about this' and talked about it.

> Interviewee 9: What teacher want, 'this has changed, then how should we teach in reality?' is what teachers are curious about and is a problem. This problem comes up when we always talk about this. It felt like 'teach it yourself' since there is no proper textbook or anything.

> Interviewee 13: If mensuration by parts is taken out of definite integrals, then we introduce definite integral without mensuration by parts to the students. [If I were provided] an example scenario about that part by them [facilitators] investigating it in advance... but I strongly felt that they were telling us teachers to investigate ourselves and do the class since it's taken out – shifting it onto us. Teach your class according to the changes, that was it.

In the vacancy of the revised textbook, teachers were unsatisfactory about the fact that they could not see any concrete idea on the new curriculum being provided. Teachers are uncomfortable in teaching others about the new curriculum where they did not grasp the concrete idea of it. They felt that the work of MOE were transferred or left as a task to the participants.

> Interviewee 13: Well, there weren't any textbooks out yet so for me, that was kind of... For example, if the curriculum changes, then there is the textbook. And if there were teachers PD programs regarding the textbook, then there is something [textbook resource] that we can discuss or so on the curious parts we have about it, but we had nothing. Just that 'it has changed so' is being said, so I got to the thinking that could be done

The fact that the textbooks were not published yet made the teachers feel that this PD program was developed unprepared. The PD program could have been rather effective if it was one the new curriculum and the corresponding new textbooks so that teachers could discuss on the contents presented and refer to concrete examples by looking at them.

2.2.2. Transforming

While the program was being developed, there were not many resources that the developers could refer to, nor any textbooks. Hence found it difficult to fill the context of the PD packet that will be helpful in the educational situations. Nobody in the PD program developer groups was a practiced hand nor had any precedents of classroom teaching regarding the new curriculum. PD program developers had to produce a boundary object, the PD packet, via didactic transposition and textbook writing processes. This *transforming* process or nature of knowledge is the essence of boundary crossing since it involves the different background communities of practice, comprehension and interpretation.

Teachers do not take the given set of knowledge and copycat exactly of what they have heard, nor have the abilities to do that unless they are playing a voice recorder or video recorder. This boundary object also serves a dual role in this PD's boundary crossings since this artifact will be used as a providing boundary object

in the program onsite as well.

"However, there is a critical view on the scaling-up strategy that there is a challenge in each step that PD participants can hardly reach the knowledge of the PD providers" (Krainer, 2015). From the fragility of knowledge to being transformed, some teachers expressed that if the PD was given to all teachers than in scaling-up process, the intended object would be better achieved.

> Interviewee 9: Firstly, I wish there was something like a guideline, [saying] 'mainly deliver these contents'. One night and two days PD program is quite a long time period, but I cannot do that for days when I am doing a scaling-up PD program. That is difficult in reality, so if I was asked to deliver these certain contents with more focus and emphasis [would be better]. I was unsatisfied with the resources to be honest. They said they will provide us with all the resource but current situation is that I haven't been provided any. Then [if I were provided with the resources] it would be a bit easier. The resources for scaling-up PD program or something more concrete.

When the PD program participants were asked what is the most felt need as a potential facilitator, they pointed out about being provided some guidelines on what information to cover in the transmissive PD programs. The reason for this request was coming from the structure of the transmissive PD programs, since the time given for the multipliers will be much shorter than the one they had attended to. Resources such as classroom activity examples and PD packet which had description of the curriculum changes in comparison to the previous curriculum were helpful in the teachers understanding of the new curriculum.

> Interviewee 9: Providing a summary PPT or resource for scaling-up PD program would make it a bit easier to facilitate, and I think the range or amount of resource is too large that it is a bit difficult in terms of accessibility and

visibility.

Interviewee 11: As I see in my school, other subject teachers have been informed to prepare for the scaling-up PD program. They have a lot of complaint as they prepare for it; how they should do it, why they [MPOE and MOE] are shifting their job onto us, shouldn't they do it from the topline (hierarchy), they are shifting onto us because of problems like [casting] lecturers, I don't understand why we should be doing this, and so on. They have these complaints. I just quietly listen to them and am fearful thinking that 'oh my, will I have to do it?'

Despite the resource or textbooks used in the PD courses are to be used flexibly, teachers are asking for guidelines for facilitating a PD course. The ideal picture of this scaling-up PD program would be the facilitators own interpretation made to contextualize the given text to a 'living' resource so that it blends in better in the context of the particular region. However, not all teachers are ideally confident in doing so and are willing to invest so much extra time and effort into this job. The challenge of providing a whole set of scaling-up PD packet in terms of size of audience and time limit is that the facilitators might cling onto the text and rather find it a burden to be keeping that suggested guidance. A minimum guideline or guidebook for facilitators will be a big help for them since forming a supportive environment is definitely a crucial part in making the project effective.

Interviewee 4, who had participated in the training program as an audit, commented that it would have been helpful to provide abstracted resources and materials that are suitable for trainee teachers to adopt when doing the transmissive PD program which are very likely to be much shorter than the original PD program they had been to. In the following excerpt, he reflects to his belonging community of teachers.

> Interviewee 4: If I were to give a scaling-up PD program to a district's math teachers, um... [I need] somewhat more definite like... The Powerpoint [slides] were all provided, right? But it is difficult to do all that in reality because the schools won't give the teachers [facilitators] so much time. If the resource could be made compact to the amount of for example an hour or two and be provided in a more compact form, it would be better for me to facilitate a PD course. If I were to teach using the same Powerpoint [slides] for all courses in reality, it'll take more than 5 hours, which the district teachers won't be able to make. In my case, I would take out the changes in the achievement standards. I would take things out like that, and I'd like to have some resource that is summarized with the emphasis on what has changed when the teacher really teaches and what should they be careful of when teaching. For real, changes in the achievement standards are quite well informed to teachers already and curriculum resources regarding that is already spread out, so it does not seem to be such an important part. In reality, teachers need to run a class, so what is needed to teach a class right now and what contents should be emphasized when teaching students are more important. I would want to emphasize that part first, the teaching and learning methods.

Boundary objects such as the PPT slides and course materials were provided at the end of the PD programs for teachers to use from their choices. In this nature, every boundary objects carries the nature of being produced as a results of transformation as well as becoming transformed appropriately for new usage.

Yet, not every boundary objects need to be concrete. The main goal of PD programs would be to make a change in the individual participants' practice and that they not be directly seen as a solid material. The teachers possibly change their brainstorming ideas on the classroom practice or attitude towards a lesson topic.

2.3. Characteristics of Boundary Practices

Boundary practices involves engagement and participation of boundary

brokers or objects. Certain boundary practices such as group meetings is so dominantly adopted that it is imperative in boundary crossings while others are promising yet not strongly settled down as a form of practice. Also, some boundary practices were imperative in that they are regarded the most effective method in the emerging forms of PD programs where teachers are involving in sharing their experience and ideas with their own voices. However, there also exist attempting boundary practices which can expand the number of the forms and opportunities of boundary crossing.

2.3.1. Imperative

Face-to-face meetings for discussions were found to be *imperative* in boundary crossing practices no matter of which phase of the PD program project a boundary practice lies. As it was suggested by Kwon et al. (2014), the proportion of discussions and exchange of thoughts is vital in these short period PD programs. Research participants mostly chose on the group discussions by gathering teachers to be the most effective method or tool in terms of professional development.

When the groups of PD program developers design a PD program together, they become in contact and interact with each other in a certain form and place. Meetings were held additionally to the whole program meeting on <Table 8>. Smaller meetings were held online and offline whenever time was allowed for the members of topic course groups.

> Interviewee 9: Positive part was discussion. Usually in onsite PD programs, lecturers come to give a lecture and explain and that's it, but there were discussions and forming a product together which is much more memorable, than just listening.

> Interviewee 10: Doing divided classes.. discussions and group activities with teachers, doing activities together? I liked that...

The research participants were finding this group activity time as a good chance of experiencing and learning from others. The boundary practices are indispensible in meaning making of the boundary encounters and plays a vital role in that the participants like this method of communicating with different perspectives. However, gathering teachers at one site in the first place requires teachers to sign up for the PD programs, which hugely depends on the willingness of the participants.

> Interviewee 15: It is said that the 2015 National Reform Curriculum is enacted from next year, and despite that teachers are very interested, there isn't any special countermeasure on this. (...) We emphasize that student participation is good, but I think nothing will happen if we just wait for the teachers to actively participate. In my opinion, this should be encouraged constantly as in the form of indoctrination. Provide more PD programs, visit schools constantly would do so, or else, teachers spontaneously participate who are interested, only those who are interested and look up [PD programs] participate. Hence in order to spread this out a little more, I come to think shouldn't you [MOE and teacher education organizations] actively put in more [agents] to the site now.

Interviewee 15 pointed out the problem that only those who are interested are willing to look up and participate in the PD programs they are being provided with. Although quite a few research participants mentioned about some teachers' unwillingness to participate in group discussions, awaiting for all teachers to become spontaneous in enacting the new curriculum may be an ideal thought.

2.3.2. Attempting

Some *attempting* forms of boundary practices were evident in this PD program project and will be discussed in this part of the study. First of all, social networking system (SNS) such as Kakaotalk was used by all groups of developers for each PD course as a source of communication and sharing files for PD materials. It was a convenient means of communication and file sharing when not all the PD program developers are able to meet up in a short notice. They could work from their homes and save time for traveling.

In the micro perspective, boundary encounters appear within the groups at the PD onsite as multiple encounters of one-to-one. Teachers were coming from different regional parts within a number of provinces that were tied as a group. In this research, it was found that teachers even from nearby schools currently do not communicate or share ideas in person.

> Interviewee 18: The school I work in is an academic high school, so we don't have any exchanges with other schools. We are concerned only about our kids' university admissions, so we can't find exchanges and doing something with another school.

> Interviewee 13: No. We don't have that [communities inter-schools]. A teacher comes from another school, that teacher came from a nearby school. Then we know the teacher, or the teacher we know come. We don't have a community though. Not as a whole.

However, school communities have a lot of interest in scheduling and organizing the school curriculum and resources. From the interview excerpt, it can be inferred that the head teacher of mathematics department has a community with neighboring schools in the district

and shares resources regarding implementing the intended curriculum into school curriculum.

> Interviewee 10: As I see, I'm not sure because I'm not the head of the mathematics department, but I saw the head teacher somehow manages to bring nearby schools' mathematics curriculum.

> Interviewee 18: It's difficult to discuss this together, you see. We do educational proposal at school. Since each school posts this on their school website and we look at that, and we see how a school's educational curriculum is distributed and how it is organized by looking at that information posted on the website, not by putting our heads together and discuss about it.

Alike Interviewee 10, Interviewee 9's school has a school community, for all subjects and for mathematics. The head teacher suggested to form a study group of teachers to understand the new curriculum better. The culture of forming group studies or small investigations within school communities need to be encouraged in order to make the PD program become more influential at school sites.

> Interviewee 9: In the beginning of the year, the head of educational research division officially talked about forming study groups to study about the reform curriculum, in school. (...) How should we organize our curriculum and how should we operate this reform curriculum? We have already made a move but I am not sure about the details. I think they are currently doing something but mathematics department as a whole hasn't talked together yet. So this teacher, despite it's been two months already, asked me if I have any resource from the PD program I had been to. I think the school is interested about this..

Similarly, Interviewee 12's school has a well-structured mathematics teacher community within the school, and they discuss together on the school curriculum. Taking part in this PD program, she could also give comments on the curriculum scheduling.

Interviewee 12: Teachers at my school, I am not sure about the other schools, but in my school are very passionate. Math teachers at my school are very passionate. (...) Although not perfect, I did taste it [the new curriculum], that I can express my opinion on this when we are organizing the curriculum. Curriculum changes for Grade 1 students who are coming in next year. We organize not only Grade 1 [curriculum] but also [that of] 2 and 3 also, roughly saying what courses liberal arts majors need to take and put out such opinion?

Despite the small communities were made for two days, the teachers did not stay in touch with each other in communities. To extend the effectiveness of this PD program and its consequential scaling-up PD programs, continuous contact in communities of practice would be helpful in teachers generate collective understanding of the education they are doing. A group to become comfortable with its members, form a group identity or a bond, and learn to release difficulties they face when coming to work together takes a fairly long period. Typically, a group kept together for 4 to 8 weeks gives them a chance to do so (Dishon, & O'Leary, 1993).

Interviewee 10: I guess it would be continuous meetings? As I have said already, a one-time is over when we get back. If we gather again as districts, look into the changes in the curriculum again, and after listening to the changes talk about each schools and so on... as we go back, we don't talk to schools far away like for example a school in Gangnam. Since teachers talk more with nearby schools, wouldn't it be more activated if those teachers come together to talk. To be honest, that was it for me too. I didn't do any scaling-up PD program. If this aims to be connected and continuous, then it should be thirty hours not fifteen; fifteen there [at the assemblied PD program] and another fifteen back in districts. I think this isn't bad. A total of 30 hours like that.

Interviewee 12: Yes, I very think so. We are in the same department and in the same educational field, so just talking about it. Talking about the MPOE or

that school's particular atmosphere and sharing what's difficult in class or how should we explain this was really interesting.

Interviewee 19: The more communities, the better. But in order to have that someone needs to sacrifice. But for example, I have more chances (master teacher). I have many more belonging communities. There are difficulties, and most teachers would feel so. Rather than thinking that everyone will be passionate, most teachers focus on their homeroom students, not having enough energy and time to do any external activities.

More opportunities to share ideas between teachers need to be promoted and provided. Although they were given comparatively more time than other PD programs, the interaction had stopped in the PD program. Also elaborating on the ideas of this PD program, questions and ideas submitted as preliminary tasks being shared could help teachers get better understandings of what other teachers are concerned about or if their concerns are commonly shared.

Interviewee 9: There were always an assignment for each lesson, but I was curious if it was reflected in the PD course. I guess all teachers would have written something like 'I want to know about this' but there weren't anything shared or answered to that. it would have been nice to know how the PD program providers think about these, I thought.

Interviewee 13: In my opinion, since the scaling-up PD participants are also all teachers, it is difficult for them to know more. If there was to be a scaling-up PD program, then it is like a teacher and... the facilitator in the PD program itself is a teacher and the listener is a student, but that's difficult. They are all the same. Rather, I would rather sit around a table and say 'this has changed so. I took this PD program, how do you think?' and share opinions. If I must give a PD course, I would have done that. 'It was really ridiculous that I was just given a whole sheet in the PD program I had attended. They say this is taken out, what are you teachers going to do about this?' Ask and listen to each others' opinions.

Groups of foursome is often recommended for cooperative learning.

However, when the time is short, smaller groups work better since each member has more chances to be involved in the group conversation (Jacobs & Hall, 2002). Groups in this PD course was formed in the size of five or six people who are from districts or regions close by. A teacher pointed out that it could have been nice if the groups mingled up more to share and listen to more ideas between groups.

> Interviewee 10: There weren't much disappointing nor improvements to be made, but there are pros and cons. The PD course was carried out in groups, a groups of six people – this can be a merit but a demerit. Once a certain amount of ideas are shared, then there isn't much new to come out. In order to learn more new things, I thought it wouldn't be bad to mix the groups. You remember there was a class at the end where we could choose take? That wasn't mixed so much neither. I think it would have been nice if that was done. It might be my greed but I wish I could have more opportunities to deal with this. Maybe a day added. It is my greed but wouldn't it have been better if I had time to think about four or five things, when I had only thought about two this time.

Having different grouping configurations could have added a bit of variety to the teachers. Although having group discussions was pointed out as one of the most advantageous strategy adopted in this PD program, the continuity of this discussions need to be promoted by providing spaces online, for example.

One of weaknesses held by the current domestic PD programs, like most other PD program outcomes point out, is that the programs do not last long-term despite all the investment and investigations put into making them better. Maaß and Artigue (2013) suggested the setting-up of local or regional centers where teachers can be supported by being provided advice and advisors when different dissemination and implementation strategies were adopted. However, advices and advisors

not necessarily need to be located in local or regional centers since there is a rich e-environment where one only needs their cellular phones to give a video call or video conference to jointly discuss an issue within or across communities in an e-learning environment.

Despite PD program that adopts on the idea of a cascade model has been doubted of being diluting the meanings of the knowledge and content of the original PD course (Turner et al, 2017), mentoring provided by the original facilitators to the trainees to become local facilitators was carried out to support the continuous structure of PD program. Using SNS as a medium such as Facetime or Skype to communicate face-to-face on the screens was used for these particular meetings where the one-way travel takes more than 7 hours of traveling for either the mentor or mentees to meet one another. This is also possible for teachers in the same districts in a local scale, where they can meet up during school time and save the time to travel. These mentoring system in the PD program is somewhat more personalized to meet the needs of those in request. In addition, a PD program developer, who is very experienced in developing and facilitating PD programs, mentioned about how difficult it is to catch and understand the intents or the needs of teachers at the PD programs who work at different schools.

> Interviewee 8: Then in reality, the schools need to ask for it [PD programs that they are looking for]. It would be nice if there is a center or some sort of organization where they can request for providing these PD programs. It would be effective if the PD programs have what the school is wanting as their PD content, and once that is delivered to the educational centers, they can make plans and develop programs that can be provided [to the teachers and schools].

As an experienced teacher and facilitator, Interviewee 8 suggested

teachers or schools to request for the provision or development of PD programs that are customized to their needs to get the most out of it. Although this may seem implausible instantly, accumulation of voices can become the essential in designing a PD program that really targets to be tailored for those who are attending it. This attempt also helps the facilitators to prepare themselves as PD course facilitators and mutually grow as onsite teachers.

Ⅴ. Conclusion

The purpose of this study is to describe the different boundary encounters in professional development programs and the characteristics of each boundary elements by looking at the case of the 2015 National Reform Curriculum PD program project. To accomplish this goal, I have defined the different phases of project and identified when the boundary encounters occur and what its constituents are in terms of boundary brokers, boundary practices and boundary objects. Then I have qualitatively analyzed the experiences of PD program developers and facilitators, who were boundary brokers, in order to identify and describe the different characteristics each boundary elements show.

This study's research questions are as follows:

1. What are the constituents of the boundary encounters in the 2015 National Reform Curriculum PD program project?
2. What are the characteristics of boundary elements in the 2015 National Reform Curriculum PD program project?

Research question 1 was first explored by looking at the 2015 National Reform Curriculum PD program project using the framework based on literature review on boundary crossing and its elements. In the whole course of the project, two boundary encounters could be defined by the two distinguishable phases. Different boundary elements were identifiable in the different boundary encounters.

In the first phase, there was a boundary encounter in the PD program development. Delegations of teachers, a university professor and an MOE administrator were the boundary brokers who were

crossing back and forth between their original jobs and as a PD program developer. Boundary practices were carried out in several forms such as online and offline meetings, reading texts, writing book chapters, revising and so on. PD source book on common course Mathematics from the PD program carried out a year before was a given artifact to be used, while the structure and schedule of the PD program and PD packet were produced as a result. All of these were boundary objects in the first boundary encounter.

In the second phase, another boundary encounter was evident in the PD courses. Teachers from different affiliations gathered as well as the PD program facilitators who are also teachers – they are the developers from phase 1. The boundary practices adopted were mostly in forms of discussions as well as listening, understanding and asking questions. As for the boundary objects, each of the PD program participant was given a PD packet and in groups they carried out teamwork by the games and activity materials prepared by the PD program developers. Also, with the facilitation of the PD program developers, whole sheet posters, nonconcrete ideas were shared in the onsite PD courses, and assignments were produced in the preliminary PD course.

However, this study looked further into these boundary crossings and their elements in terms of the constituents such as when and how they appear than just listing the identified correspondents of the existing frameworks. It was found that the disparities in the delegations of people produces a boundary in both phases, which are called the boundary encounters. The boundary encounters have been spotted as potential meaning formation and development rather than struggles and barriers between the different boundary brokers. Boundary practices were the space and time in various forms in order

to form mutual understandings of the boundary brokers. Lastly, boundary objects were the product and reference of concretization and contextualization of knowledge and ideas.

The results of research question 2 are summarized as the following. The characteristics of boundary brokers were categorized as comprehending, reflecting, negotiable, and motivating. *Comprehending* is reading texts and understanding ideas. *Reflecting* is referring to their experience in the past or as a teacher. *Negotiable* is taking in ideas of different perspective and collaborating with them. *Motivating* is making changes in others by influencing them with own ideas. Teachers involved in PD programs were not simply receivers of information being delivered but taking different stances of practices to select and reorganize the information they were exposed to.

Boundary objects were identified in two forms: a medium of boundary crossing and its outcome via the boundary practices. When it is the medium of boundary crossing, it usually serves as *providing* information and knowledge to be negotiated. When it is the product of boundary practices or boundary crossings, it is usually transformed, hence has the characteristic of constantly *transforming* as it becomes in contact with the boundary brokers at the boundary encounters. Despite there is a voice saying that the transformation of the intended knowledge diffuses the meaning it originally holds, the transforming characteristics of boundary object in this study is seen as knowledge adapted to contexts or newly produced through boundary brokering of multiple participants.

Boundary practices can be carried out in several different forms. However, group discussions in meetings is dominant and contingent that it is *imperative* in boundary crossings, while others are probable or promising yet not strongly settled down as a form of

practice hence characterized as *attempting*. The latter can be optionally adopted depending on the purpose of boundary crossing is having.

This study identified the constituents of different boundary encounters and the characteristics of boundary crossings by analyzing in-depth interviews and documents related to the PD program. Despite the numerous research on teacher education and professional development, they focused on the factors that lead to the success of a program by an observer's view. This research extends its focus to the nature of PD program by the intact voices of the insiders. Hence, first of all, the findings in this study serve to be a preliminary framework for any of those who are involved in or related to PD programs. Using this emerging framework as to understand the main agents can aid in various ways such as for those who are designing and preparing for PD programs as developers or facilitators, preparing to take PD courses as participants, and analyzing the phenomena or experience of people involved as researchers. Considering or defining what the different boundary elements would be in a PD program will possibly shape its goal and direction.

Secondly, having understood that boundary can appear in any PD program, PD contents as well as the goals of participation need to be reminded and emphasized. As Turner, Brownhill, & Wilson (2017) had addressed the diffusion of the meaning knowledge to be problematic in a scaling-up PD program, the knowledge and content needs enough time to be "digested" by the consumers. Even lead teachers are not always confident to share the contents of the completed PD programs with other teachers. This diffusion in the knowledge and its meaning most likely comes from the misunderstanding or inconsistency in goals between those who are carrying out and taking the PD programs. By reading and discussing

with enough time to form a mutual goal and understanding would combat the worries on knowledge omission in a nationwide scale cascade model PD program.

To conclude, having better understanding on what the constituents are and how the characteristics of boundary crossings are like in PD programs is beneficial in terms of the effect of PD program in reality as well as in research. Most PD programs present their finale with statistics using scales of satisfaction surveyed to the participants. However, qualitative research on the experiences of the people concerned in the PD programs will accelerate the effects reaching classrooms and design more customized PD programs for teachers who are in need of them. Hence there is a need to develop the framework on the characteristics of boundary crossings as well as to refine its descriptions by further investigations.

REFERENCES

Akkerman, S., Admiraal, W., Simons, R. J., & Niessen, T. (2006). Considering diversity: Multivoicedness in international academic collaboration. *Culture & Psychology, 12*(4), 461-485.

Akkerman, S. F., & Bakker, A. (2011). Boundary crossing and boundary objects. *Review of educational research, 81*(2), 132-169.

Bodgan, R., & Taylor, S. J. (1975). Introduction to qualitative research methods. New York.

Cho, J. Y., & Lee, E. H. (2014). Reducing confusion about grounded theory and qualitative content analysis: Similarities and differences. *The Qualitative Report, 19*(32), 1.

Creswell, J. W. (2007). Qualitative Inquiry & Research Design: Choosing Among Five Approaches. Thousand Oaks: Sage.

Derry, S. J., DuRussel, L. A., & O'donnell, A. M. (1998). Individual and distributed cognitions in interdisciplinary teamwork: A developing case study and emerging theory. *Educational Psychology Review, 10*(1), 25-56.

Dishon, D., & O'Leary, P. W. (1993). A Guidebook for Cooperative Learning: A Technique for Creating More Effective Schools (rev. ed). Holmes Beach, FL: Learning Publications.

Farmer, J. D., Gerretson, H., & Lassak, M. (2003). What Teachers Take from Professional Development: Cases and Implications. *Journal of Mathematics Teacher Education, 6*(4) 331-360.

Gilpin, A. (1997). Cascade Training: Sustainability or Dilution. In I. McGrath (Ed.), *Learning to Train: Perspectives on the Development of Language Teacher Trainers* (pp. 185 - 195). Prentice Hall Europe.

Hayes, D. (2000). Cascade training and teachers' professional development,

ELT Journal, 54(2), 135-145.

Hermans, H. J., & Kempen, H. J. (1993). *The dialogical self: Meaning as movement.* Academic Press.

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative health research, 15*(9), 1277-1288.

Huang, R., & Bao, J. (2006). Towards a model for teacher professional development in China: Introducing Keli. *Journal of Mathematics Teacher Education, 9*(3), 279-298.

Hwang, H. J., Na, G. S., Choi, S. H., Park, K. M., Lim, J. H., & Seo, D. Y. (2016). New Theories on Mathematics Education. Seoul: Moonumsa.

Jacobs, G. M., & Hall, S. (2002). Implementing Cooperative Learning. In Richards, J.C. & Renandya, W. A.(Ed). Methodology in language teachings: An Anthology of Current Practice. Cambridge University Press.

Kaur, B., Kwon, O. N., Leong, Y. H. (2016). Professional Development of Mathematics Teachers: An Asian Perspective. Springer Nature Singapore.

Kieran, C., Krainer, K., & Shaughnessy, JM. (2013). Linking research to practice: Teachers as key stakeholders. In Clements, M.A. et al. (ed.) *Third international handbook of mathematics education*, 361-392. New York: Springer.

Kim, E-G., Ahn, J-Y., Kim, H-J., Kim, J-H., & Yu, W. (2016). Effects of Teachers' Interest in the 2015 National Curriculum on the Intention to Participate in Professional Development. *The Journal of Curriculum and Evaluation, 19*(1), 23-47.

Kim, Y. C. (2016). Qualitative Research Methodology. Paju: Academy Press.

Krainer, K. (2011). Teachers as stakeholders in mathematics education

research. In B. Ubuz (Ed.), *Proceedings of the 35th Conference of the International Group for the Psychology of Mathematics Education* Volume 1: 47-62. Ankara, Turkey: PME.

Krainer, K. (2015). Reflections on the increasing relevance of large-scale professional. *ZDM, 47*(1), pp.143-151.

Kwon, O. N., Park, K-M., Lim, I. H., & Heo, R-K. (1999). A Study on the discourses related to mathematical aptitude in high school students. *Journal of Educational Research in Mathematics, 9*(1), 351-367.

Kwon, O. N., Park, K. H., Kim, S. S., Lee, J. R., Shin. J. K., Lee, J. S., Seo, B. E., Lee, D. H., Park, J. S., Park, J. H., Oh, H. M., Park, J. H., & Choi. S. I. (2014). *Developing a mathematics professional development program*. Korea Foundation for the Advancement of Science & Creativity.

Kwon, O. N., Kim, O. H., Park, M. S., Park, M. H., Park, J. S., Park, J. H., Yoon, S. J., Lee, M. H., Lee, C. S., Cho, K. H., & Choi, I. S. (2017a). *2015 National Reform Curriculum High School Mathematics Lead Teacher Professional Development packet*. Seoul National University Center for In-service Teacher Education.

Kwon, O. N., Kim, O. H., Park, M. S., Park, M. H., Park, J. S., Park, J. H., Yoon, S. J., Lee, M. H., Lee, C. S., Cho, K. H., & Choi, I. S. (2017b). *2015 National Reform Curriculum High School Mathematics Lead Teacher Professional Development Results Report*. Seoul National University Center for In-service Teacher Education.

Lee, H. K. (2005). A phenomenology of textbook writing experience. *The Korean Society for the Study of Anthropology of Education, 8*(1), 91-124.

Lee, K. H. (1996). Understanding of The Didactic Transposition Theory. *The Journal of Educational Research in Mathematics, 6*(1), 203-213.

Lee, K. H., Na, G. S., Kwon, N. Y., Kim, D. W., Lee, H. C., Lee, D. H., Ko, E. S., Park, M. S., Park, M., Lee, E. J., Cho, J. W., & Park, J. H. (2012). A Preliminary Study on Designing PDS Model for Korean Mathematics Teachers. *Journal of Educational Reserach in Mathematics, 22*(4), 581-602.

Leong, Y. H., Tay, E. G., Toh, T. L., Yap, R. A. S., Toh, P. C., Quek, K. S., & Dindyal, J. (2017). Boundary Objects Within a Replacement Unit Strategy for Mathematics Teacher Development. In Kaur, B., Kwon, ON.,, Leong, YH(2016). *Professional Development of Mathematics Teachers* (pp. 189-208). Springer Singapore.

Maaß, K., & Artigue, M. (2013). Implementation of inquiry-based learning in day-to-day teaching: a synthesis. *ZDM, 45*(6), 779-795.

Margalef, L., & Pareja Roblin, N. (2016). Unpacking the roles of the facilitator in higher education professional learning communities. *Educational Research and Evaluation, 22*(3-4), 155-172.

Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education.* CA: Jossey-Bass Publishers.

Ministry of Education. (2015). Elementary and Secondary Curriculum General Guideline. *MOE Notification, 2015-74*, Vol. 1.

Park, E. A., Kim, M. J., Kim, S. B., Park, J. H., Seo, M. C., Kang, D. H., Kang, S. J., Kim, N. J., Cho, C. G., Kil, H. J. (2016). A Study on developing in-service teacher training programs for 'integrated social studies' in the 2015 revised national curriculum. Korea Institute for Curriculum and Evaluation Research Report CRC; 2016-3.

Park, H. K. (2016). Analysis of Issues and Challenges Regarding

Educational Content Development in the Process of National Curriculum Development: Focusing on the Perspectives of Participants (Doctorate dissertation). Graduate school of Ewha Women's University, Republic of Korea.

Remillard, J. T. (1999). Curriculum materials in mathematics education reform: A framework for examining teachers' curriculum development. *Curriculum Inquiry, 29*(3), 315-342.

Schreier, M. (2012). Qualitative content analysis in Practice. London : The SAGE

Schreier, M. (2014). Qualitative content analysis. *The SAGE handbook of qualitative data analysis*, 170-183.

Sherin, M. G., & Drake, C. (2009). Curriculum strategy framework: Investigating patterns in teachers' use of a reform-based elementary mathematics curriculum. *Journal of Curriculum Studies, 41*(4), 467-500.

Sztajn, P., Wilson, P., Edgington, C., & Myers, M. (2014). Mathematics professional development as design for boundary encounters. *ZDM, 46*(2), 201-212.

Tsui, A. B., & Law, D. Y. (2007). Learning as boundary-crossing in school-university partnership. *Teaching and teacher education, 23*(8), 1289-1301.

Turner, F., Brownhill, S., & Wilson, E. (2017). The transfer of content knowledge in a cascade model of professional development. *Teacher Development, 21*(2), 175-191.

Wenger, E. (1998). *Communities of practice : learning, meaning, and identity.* NY : Cambridge University Press.

Zwetzschler, L., Rösike, K., Prediger, S. & Barzel, B. (2016). Professional development leaders' priorities of content and their views on participant-orientation. Retrieved from http://www.mathematik.uni-dortmund.de/~prediger/veroeff/16-ICME-Facilitators-Zwetzschler-etal.pdf

Zaslavsky, O. & Leikin, R. (2004). Professional Development of Mathematics Teacher Educators: Growth Through Practice. *Journal of Mathematics Teacher Education, 7*(1), 5-32.

국문초록

수학과 교사 연수에서 나타난 경계 넘나들기의 구성과 특징에 대한 분석

연수 현장에서 교사들의 참여가 강조되고 있는 추세에서 교사들은 연수 참여자로 때로는 더 나아가 연수 참여자에서 연수 진행자로의 소속과 역할 변화를 경험하게 된다. 교사들은 계속적으로 공동체 간 경계를 넘나들면서 다른 참여자들과 함께 협력하고 연수 과정과 자료를 통해 새로운 자료를 창출하며, 잠재적으로는 자신의 교수활동에 대해 변화를 가져온다. 연수 프로그램과 관련하여 다양한 연구가 이루어져 왔지만 주로 이론적 탐색과 연수 결과 분석을 통한 연구 설계형 프로그램 개발이 대부분이었다. 그리고 연수 경험에 관한 연구로는 연수 전후로 수집된 연수 참여자들의 설문 결과나 연구자가 개발진으로 참여했던 경험을 바탕으로 이루어져 왔다. 연수를 개발하는데 연수 프로그램에서의 교사들의 경험은 중요한 연구 주제임에도 불구하고 이를 질적으로 분석함으로써 이들에게 요구되는 경계 넘나들기의 구성이나 특징에 대한 연구는 없었다.

이 연구에서는 2015 개정 교육과정에 따른 2017년 선도교원 연수를 하나의 사례로 보고, 교사인 연수 개발자와 연수 참여자들의 경험을 인터뷰하였으며, 인터뷰는 녹음하여 그 내용을 전사록으로 옮겼다. 그리고 전사록과 연수 자료집을 비롯한 연수 자료들의 분석을 통해 경계 조우들의 구성을 구성 요소와 언제, 왜 나타나는지, 그리고 경계 요소들의 특징들이 어떠한지 두 가지로 살펴보았다. 질적 내용 분석을 통해 이 연구

에서는 이러한 경계 조우가 언제 생겨나는지, 경계를 넘나드는 데에 어떠한 특징들이 있는지 밝히고자 하였다. 이에 따른 이 연구의 연구 질문을 '2015 개정 교육과정에 따른 2017년 선도교원 연수 개발에서 나타난 경계 조우들은 어떻게 구성되어 있는가?' 그리고 '2015 개정 교육과정에 따른 2017년 선도교원 연수에서 나타난 경계 넘나들기의 특징은 무엇인가?'로 설정하였다.

연구 결과, 서로 다른 경계 조우는 다른 공동체 소속의 사람들이 관점의 차이를 띨 때 나타나며, 각기 연수 사업의 다른 과정에서 나타나는 것을 확인할 수 있었다. 이 때, 경계들은 불연속의 장벽보다는 새로운 의미를 형성하거나 발전하는 곳으로써 볼 수 있었다. 경계 관행은 다양한 공동체가 모인 목적에 따라 공통의 이해를 형성하고 아이디어를 발전하는 시너지를 노린다. 그리고 협상의 결과물로써 각 공동체 혹은 공통의 지식을 맥락화하거나 구체화하는 것으로 드러났다.

그리고 경계 넘나들기의 특징들은 각 경계를 구성하는 요소들로써 구분지어 설명하였다. 경계를 넘나드는 주체는 '이해하기', '반성하기', '협상하기', '동기부여하기'으로 특징지어졌다. '이해하기'는 글을 읽거나 아이디어를 이해하는 것으로 서로 다른 지식이나 생각을 공유하고 개방적인 자세로 듣거나 접하는 형태를 취한다. '반성하기'는 기존의 소속이나 역할에서의 경험을 비추어보는 것으로 현재 경험하는 것을 비교해보는 과정이다. '협상하기'는 기존에 알고 있는 내용을 재확인하여 강화하거나 새로 접한 것을 얼마나 어떻게 수용할지에 대한 결정 과정이다. '동기부여하기'는 변화를 추구하는 과정으로 타인이나 연수 참여 경험으로써 자극을 받아 본인의 생각이나 행동에 변화를 이끌어내는 과정이다. 경계 인공물은 경계 넘나들기의 매개 혹은 결과물인지 그 성격에 따라 '정보 제공하기'와 '변형하기'로 구분 지어졌다. 마지막으로 다양한 형태의 경계 활동은 연수에서의 경계 넘나들기에 있어 '필수적'이거나 '도전적인' 것으로 구분되었다.

이 연구에서는 교사들이 본래 소속된 공동체에 따라서 각기 다른 목적과 목표를 가지고 연수에 참여하는 것을 확인할 수 있었다. 질적 분석을

통해 도출된 연구 결과는 연수를 개발하고 실행하는데 있어 나타나는 경계 넘나들기의 구성과 특징들에 대한 개관을 제시하였다. 연수에 참여하는 교사들은 두 공동체 사이 경계를 넘나들 때 상황에 수동적이기보다 능동적으로 반응하며 전략적으로 자신의 위치와 역할을 만들어간다면 그 기회를 효과적으로 활용할 수 있을 것이다. 이를 통해 추후 연수 프로그램을 개발할 때 대상, 자료, 그리고 활동들로 연수를 설계할지 고려해볼 수 있다. 위치와 역할의 변화가 요구되는 연수 참여자들을 살펴보거나 연수를 준비하는 데 고려할 수 있는 분석틀로써의 역할을 기대한다.